554

SCIENTIFIC LIBRARY

UNITED STATES PATENT OFFICE

CASE _____ SHELF _____

GOVERNMENT PRINTING OFFICE 11—8625

VM
1
.M15

LIBRARY
MAR 5 1929
U. S. PATENT OFFICE

RUB 2 COM 18

MARINE ENGINEERING

AND SHIPPING AGE

LIBRARY
AUG 16 1922
U. S. PATENT OFFICE

INDEX TO VOLUME XXVI

29

21265

JANUARY TO DECEMBER, 1921

PUBLISHED BY

ALDRICH PUBLISHING COMPANY

IN CONJUNCTION WITH

SIMMONS-BOARDMAN PUBLISHING CO.

Woolworth Building, New York, U. S. A.

34 Victoria Street, Westminster, S. W. I., London, England

MARINE ENGINEERING
AND SHIPPING AGE

INDEX TO VOLUME XXVI

JANUARY TO DECEMBER, 1921

INDEX

Note—Illustrated articles are marked with an (*) asterisk.

ARTICLES

Aba, motor passenger liner *934
Acetylene for ship's lighting 587
Adler, sea-going tug *747
Administration, new, assumes responsibility for American merchant marine. Waldon Fawcett 34
Admiral Line: Passenger steamship Wenatchee *438
A. E. G. Diesel engines *700
Aeolus, steamship re-conditioned. H. G. Crosby *1
Air compressors for motorships 930
Air valve, pressure seated "Cleco." Cleveland Pneumatic Tool Co *452
Albert Otto & Son, Inc.: Air compressors for motorships 930
All America, cable steamer *207
Allowances, weight 140
American Bureau of Shipping 37
American Car & Foundry Co.: "Harrold" rivet gun 896
American classification of American ships. W. A. Dobson 901
American destroyer hits mine in the Baltic. Commander E. S. Land *139
American Engineering Co.: Electrically driven auxiliaries 898
American marine insurance syndicates 40
American marine week an unqualified success *889
"American marine week" success assured *809
America, schooner yacht (photograph) *934
American shipbuilding—present and future *25
American shipping gaining strong position in north transpacific commerce *768
American shipyard apprenticeships, evening schools and scholarships. Charles F. Bailey 911
American Steel Foundries, locking device for stockless anchors *602
Americanization of our merchant marine. "Old Scotch" 662
Anchors, locking device for stockless *602
Anderson, E. H. B.: Notes on operation of turbines 445
Anglesmithing, modern. Maurice Nicholls *135
Anglo-American Oil Co.: motorship Narragansett *16
Annin, Robert E.: Present indications regarding ship operation 879
Ano, C.: Electrically propelled freighter Biyo Maru *593
Anschutz & Co.; Self-steering gyro-compass *463
Apparatus designed to increase evaporator efficiency. Griscom-Russell Co *816
Approximate stability formulæ. Heinrich Schultz *481
Arc welded ships. O. H. Eschholz *54
Arc welding equipment at Newport News yard *406
Arc welding units, gas engine driven *621
Are you a marine engineer, Edison standard? "Old Scotch" 755
Are you a shipping man, à la Edison? "Old Scotch" 807
Armstrong, Sir W. G., Whitworth & Co., Ltd. *213
Armstrong, Sir W. G., Whitworth & Company, Ltd.: Meat carrier Tairo *583
Armstrong, Sir W. G., Whitworth & Co. 10,000-ton tanker *12
Armstrong, Sir W. G., Whitworth & Company's yard *105
Arnott, David: Rules and regulations for freeboard *306
Arrow Pump Co.: Rotary geared pump for cooling marine engines *708
Ash ejector. Victor Engineering Co 816
Ash ejector operates without a pump *929
Atlantic, Gulf and Pacific Company: ferry boat Poughkeepsie *750
Atlantic Refining Company. Tanker H. C. Folger *597
Atlantic Refining Company. Tanker Herbert L. Pratt *597
Atlantic Refining Company. Tanker J. E. O'Neil *597
Atlantic Refining Company. Tanker W. M. Burton *597
Atlantic Refining Company. Tanker W. M. Irish *597
Atlantic Refining tankers, new machinery for *597
Atlas Valve Company, pump governors 636
Automatic cargo handling proposed *166
Automatic starter for squirrel cage motors. Cutler-Hammer Mfg. Co *775
Auxiliary motors. General Electric Co 898
Auxiliaries, electric motors for merchant ship. Walter E. Thau and William H. Easton *613
Auxiliaries, electrically driven. American Engineering Co 898
Auxiliaries, ship, electricity applied to. H. L. Hibbard 463

Babcock & Wilcox oil separator *156
Back up the new Shipping Board *501
Bailey, Charles F.: American shipyard apprenticeships, evening schools and scholarships 911
Balancing engines. C. H. Peabody ..*407, 477
Balsa insulation for refrigerator ships *557
Baltimore Dry Docks & Shipbuilding Co.: Reconditioned steamship Aeolus. H. G. Crosby *1
Barges, electrical equipment for Erie canal 839
Barry, Capt. R. E.: Random notes by an old Seaman *137, 688
Bates, James L.: Curves of effective horsepower *678
Bath Iron Works: S. S. Thomas P. Beal *913
Battle cruiser Ranger, United States *439
Battle cruisers, possible conversion of 873
Battleship California, United States (photographs) *754
Battleship Colorado, U. S. (photograph) *433
Battleship Maryland, United States *595
Battleship Maryland, United States, dock trials 439
Battleship Ostfriesland, former German, used as target for bombing test (photograph) *611
Battleship Tennessee, final trials *513
Battleship Tennessee, propelling machinery of *269
Battleship Washington launched at Camden *752
Battleships the United States may scrap (photograph) *924
Berg, Eskil: Marine steam practice 157
Berg, Eskil: Turbine reduction gears versus electric propulsion 390
Berths, built-in *296
Bethlehem Shipbuilding Corporation, combined screw and spring quadrant steering gear *685
Bethlehem Shipbuilding Corporation, deck machinery for Standard Oil tankers 622
Bethlehem Shipbuilding Corporation, electric steering gear *15
Bethlehem Shipbuilding Corporation, ore and coal carriers Chilore and Lebore *364
Bethlehem Shipbuilding Corporation: Ore and oil steamer G. Harrison Smith *844
Bethlehem Shipbuilding Corporation: Ore and oil steamers Marore and Steelore *283
Bethlehem Shipbuilding Corporation, reconditioned steamship Minnekahda *520
Bethlehem Shipbuilding Corporation: Record of electric arc welding work *61
Bethlehem Shipbuilding Corporation, 6,000-ton dry dock at Sparrows Point *603
Bethlehem Shipbuilding Corporation, steamship Hawkeye State *185
Bethlehem Shipbuilding Corporation. Tanker H. C. Folger *597
Bethlehem Shipbuilding Corporation. Tanker Herbert L. Pratt *597
Bethlehem Shipbuilding Corporation. Tanker J. E. O'Neil *597
Bethlehem Shipbuilding Corporation. Tanker W. M. Burton *597
Bethlehem Shipbuilding Corporation. Tanker W. M. Irish *597
Bethlehem Shipbuilding Corporation. Tankers Henry Deutsch De La Meurthe and Emily Deutsch De La Meurthe *547
Bill of lading notations 806
Binda, John L.: Ship operators interested in foreign trade 727
Biyo Maru, electrically propelled freighter. C. Ano *593
Blohm and Voss Diesel engine *700
Blohm and Voss: White Star liner Majestic *735
Blowers, special service. B. F. Sturtevant Co. *896
Board of Trade survey fees 437
Boiler shop of Federal shipyard *443
Boiler water, apparatus for measuring the salinity of *635
Boilers, Scotch, marine, quantity production of *443
Bonner, William T.: Progress of welding in the shipyards *57
Bookcases, plans of *368
"Bordereaux": Developments in marine insurance 805, 886
Boston harbor ferryboats *826
Brace up, America! Don't give up the ships!! C. A. McAllister 31
Bragg, E. M.: Influence of shape of transverse section upon resistance 909
Branch banks abroad—their ability to cooperate with an American merchant marine. George E. Roberts 39
Bribery, the effort to stamp out commercial. Waldon Fawcett 384
British frozen meat cargo steamer Tairoa. *583
British India Steam Navigation Company: passenger steamer Modasa 167
Broadening the use of welding in shipbuilding. F. B. Webster *852
Brocklebank, Ltd., T. and J.: Motorship Malia *935
Bunker fires 732
Bunker oil, RanD system for 314
Burden for shipowners proposed, another. Waldon Fawcett 511
Burmeister and Wain Diesel engine *700
Burmeister & Wain, Ltd.: motorship Malaya *701
Burmeister and Wain: motorship Java 934
Burmeister & Wain: Twin screw motorship Formosa *739
Burntisland Shipbuilding Company: Wine steamers Nelly Lasry and Sidney Lasry. *360

Cable steamer All America *207
Caird & Company: passenger and mail steamship Naldera *195
Calculation of transverse strength of submarines by Marbec's method. William Hovgaard 907
California, United States battleship (photograph) *754
Cammell Laird & Company, Ltd.: steamship Oropesa *351
Cammell Laird & Company: steamship Samaria *115
Cammellaird Fullagar Diesel engine *545
Canada wins fishermen's trophy *818
Canal, lock control of New Orleans *302
Capstan, designed for heavy loads on dry dock *622
Cargo and passenger steamer Oropesa *351
Cargo and passenger steamship Hawkeye State *185
Cargo and passenger steamship Mount Carroll *363
Cargo and passenger vessel San Lorenzo *430
Cargo and refrigerator steamer City of Pekin *657
Cargo handling, automatic, proposed *166
Cargo space, to compute 211
Cargo steamer Biyo Maru, electrically propelled. C. Ano *593
Cargo steamer Manulani *707
Cargo steamer, meat, Tairoa *583
Cargo steamship Newton *119
Cargo steamship Ville de Dannemarine, launch of 71

Cargo steamships Nelly Lasry and Sidney Lasry. *360
Cargo transferring speed per linear foot... *779
Cargo vessel, modern. William Gatewood. 381
Casting propellers, modern methods..... *696
Catch the Bees. "Old Scotch."..... 300
Certificate, insurance..... 731
Chace, Mason S.: Development of the three-plane navy, with or without battleships 900
Chairman of the Shipping Board, the new. *503
Chalkley, A. P.: Motorship Malia..... *935
Chalkley, A. P.: new Sulzer Diesel engine. *845
Chantiers et Ateliers de Penhcët: S. S. Paris *669
Chapman, Lawrence B.: Fuel problem for. 465
Chapman, Lawrence B.: Selection of propelling machinery. 691
Chilore and Lebore, ore and coal carriers.. *364
Chuck for holding broken drill shanks. Wayne Tool Mfg. Co..... *633
Cincinnati, United States scout cruiser.... *121
City of Pekin, refrigerator and cargo steamer *657
Claims against the Government. Waldon Fawcett 298
Classification Society, American Bureau of Shipping 37
Cleaning ships' bottoms without docking ..*221
Cleveland Pneumatic Tool Co.: "Cleco" pressure seated air valve *452
Clinton Dry Docks: Valveless reciprocating pump 898
Close quarter deck planing machine. Swan, Hunter & Wigham Richardson, Ltd..... *754
Clutch coupling, magnetic. Sperry Gyroscope Co. *817
Coal trade, use of idle ships in 802
Coaling ships by portable belt conveyor.. ..*837
Coast Guard cutter, electrically propelled... *825
Cochrane and Sons, Ltd.: Trawler Rudyard Kipling *665
Coen mechanical oil burning system 566
Colombia, Foreign trade with..... 138
Colorado, U. S. battleship (photograph)... *433
Combination ore and oil steamer G. Harrison Smith *844
Combined screw and spring quadrant steering gear *685
Combustion recorder, maintains double analysis of flue gases *656
Commerce on Great Lakes during July .. 687
Commerce passing through Panama Canal during 1920 ..... *392
Commercial schedules, regular 878
Compagnie Generale Transatlantique: Passenger ship Lamoriciere 301
Compagnie Generale Transatlantique: S. S. Paris *669
Compass, radio, on shipboard *620
Compass, self-steering, Anschutz..... *462
Compositions and and non-ferrous metals. Horace Holden Thayer 524
Comrie safety hook *380
Concord, United States scout cruiser..... *274
Concrete ships, not insurable risk 805
Conde de Churruca, motorship *776
Construction news, marine....181, 265, 347, 421, 494, 570, 644, 718, 791, 867, 943
Continuous course and speed recorder. Sperry Gyroscope Co. *817
Construction: Ships and their. C. H. Peabody 42
Convention, National Merchant Marine Association 158
Convention of Naval Architects and Marine Engineers, annual *899
Convention of the Marine Draftsmen, program of *811
Convention of the Society of Naval Architects and Marine Engineers, program of meeting 810
Cook, S. S.: Double reduction gears for merchant ships 394
Cost accounting and estimating. H. H. Schulze 907
Cost of Danish shipping 146
Cotton controversy, Egyptian. Winthrop L. Marvin 655
Cotton controversy settled, Egyptian..... 878
Coupling, magnetic clutch. Sperry Gyroscope Co. *817
Course and speed recorder, continuous. Sperry Gyroscope Co. *817
Covic Electric Co., electric welding plant mounted on truck. *56
Crandall Engineering Co.: Longitudinally trussed dry dock 896
Crane, floating, derricking jib type..... *591
Crane, floating, 60-ton self-propelling..... *684
Crane, Industrial crawling tractor..... *833
Crane, Northwest, crawler *331
Crankshafts, Diesel engine. Joseph Hecking *147
Crosby, H. G.: Steamship Aeolus reconditioned *1
Crowell and Thurlow Steamship Company: S. S. Thomas P. Beal *913
Cubist ship Newton *119
Cunard Steamship Company, Scythia *819
Cunarder Samaria, new *115
Cunningham, Jr., Henry: Freight handling at New York barge terminal..... *592
Curves of effective horsepower. James L. Bates *678
Cutler-Hammer Mfg. Co.: Automatic starter for squirrel cage motors *775

Damage, sweat 806
Damage, unrepaired 806
Danish shipping, Cost of 146
Danzig, shipyards active *599
Data sheet, British frozen meat cargo steamer Tairoa 584
Data sheet for passenger steamship Aeolus. 118
Data sheet, freighter Thomas P. Beal..... 915
Data sheet, ore and coal carriers Chilore and Lebore 366
Data sheet, ore and oil steamers Marore and Steelore 283
Data sheet, passenger and cargo steamer Oropesa 356
Data sheet, passenger and cargo steamship Hawkeye State 190
Data sheet, passenger and cargo vessel San Lorenzo 432
Data sheet, passenger liner George Washington 508
Data sheet, passenger steamship Giulio Cesare 428
Data sheet, Peninsula & Oriental liner Naldera 200
Data sheet, refrigerator and cargo steamer City of Pekin 658
Data sheet, steamship Paris 672
Data sheet: tankers San Lamberto and San Leon 515
Data sheet, trawler Rudyard Kipling 666
Data sheet, twin screw motorship Formosa. 741
Data sheet, wine steamers Nelly Lasry and Sidney Lasry 362
Davis, V. F.: Handy steam velocity and steam flow tables 522
Davits, lifeboat, gravity type *323
Deck machinery for standard oil tanker.... 622
Decking, magnesite composition 295
Decks, plans of..... *523
Derricking jib type floating crane..... *591
Design and construction of passenger steamers. E. H. Rigg 908
Design, new, 10,000-ton tanker *12
Destroyers, successful performance of recent *209
Detecting salt in boiler feed water *930
Detroit, United States scout cruiser *274
Development of the three-plane navy, with or without battleships. Mason S. Chace. 900
Developments in marine insurance. "Bordereaux" 731, 805, 886
Devices, new, exhibited at the marine exposition *816, 896
Dickinson, E. D.: Electric auxiliaries on merchant ships 903
Diesel electric drive on ocean-going freighter 388
Diesel-electric ferryboat Poughkeepsie. C. V. S. Wyckoff *750
Diesel electric propulsion, correction 710
Diesel electric propulsion. J. B. Bassett.. 631
Diesel-electric yacht Guinevere, trials of.. 728
Diesel engine, A. E. G..... *700
Diesel engine, Blohm and Voss..... *700
Diesel engine building in Europe, marine. Special London Correspondent *49
Diesel engine, Burmeister and Wain..... *700
Diesel engine, Camellaird Fullagar..... *545
Diesel engine construction, innovations in. Special London Correspondent *700
Diesel engine crankschafts. Joseph Hecking *147
Diesel engine, Doxford *628
Diesel engine, Lombard, 4-cycle..... *778
Diesel engine, long stroke, Harland and Wolff *468
Diesel engine, new, Vickers, Ltd. *389
Diesel engine, North British Diesel Engine Works, Ltd. *468
Diesel engine, Still *468, *545
Diesel engine, Sulzer *545
Diesel engine, Sulzer two cycle *321
Diesel engine, Vickers *700
Diesel engine, Vickers-Petters *321
Diesel engine, Werkspoor *229
Diesel engines, Germany to build high powered. Special London Correspondent *545
Diesel engines, lubrication of marine. Louis R. Ford *623
Diesel engines, standardized. H. R. Setz.. *222, 324, 391, 471, 548
Diesel engines, two versus four cycle. Special London Correspondent *321
Diesel oil engine, new Sulzer. A. P. Chalkley *845
Directory of exhibits at marine exposition. 812
Dobson, W. A.: American classification of American ships 901
Dock trials of electrically propelled battleship Maryland 439
Doxford Diesel engine *638
Draftsmen, American society of marine, membership campaign started for..... 251
Dry dock at Sparrows Point, 6,000-ton floating *603
Dry dock, floating, at Gothenburg..... *445
Dry dock, floating, at Pensacola *329
Dry dock, floating, for testing submarines. Von Klitzing *440
Dry dock, floating, largest in Pacific waters (photograph) *328
Dry dock, longitudinally trussed. Crandall Engineering Co..... 896
Dry docks, railway, at the Moore shipyard. *759
Ducey, D. F., Lieut.-commander: Our new scout cruisers *274
Duplex mono, combustion recorder *656
Dynamometer, hydraulic, Froude. C. H. Peabody *244
Dyson, C. W.: Problem of the hull and its screw propeller.....*315, 398, 453, 553, 617

Eagle, flying deck of H. M. S. (photograph) *375
East Asiatic Company: Motorship Java... 934
East Asiatic Company: Motorship Kobenhavn *933
East Asiatic Company: Twin screw motorship Formosa *739
Easthampton radio station *38
Easton, William H.: Electric motors for merchant ship auxiliaries..... *613
Eclipse, exciter sets of *11
Eclipse, performance of electrical propelling machinery on 243
"Economy, economy and yet more economy." "Old Scotch" 127
Economy, how the Shipping Board can economize. "Old Scotch."..... 231
Economy, operating. R. H. M. Robinson.. *799
Educational, Marine Engineers Beneficial Association, winter lectures for ocean engineers 97
Effective horsepower, curves of. J. L. Bates *678
Efficiency in material handling 552
Egyptian cotton controversy settled 878
Egyptian cotton controversy. Winthrop L. Marvin 655
Elder Dempster Line: Motor passenger liner Aba *934
Electric arc welding work, record of, Bethlehem Shipbuilding Corporation *61
Electric auxiliaries on merchant ships. E. D. Dickinson 903
Electric drive, Diesel, on ocean-going freighter 388
Electric motors for merchant ship auxiliaries. Walter E. Thau and William H. Easton *613
Electric propulsion, Diesel. J. B. Bassett. 631
Electric propulsion of ships. W. E. Thau. 901
Electric propulsion of ships. W. E. Thau. *925
Electric propulsion versus turbine reduction gears. Eskil Berg 390
Electric ship propulsion. W. L. R. Emmet 44
Electric siren for motorships *153
Electric steering gear on Standard Oil barges *15
Electric welding plant mounted on motor truck *56
Electrical equipment for Erie Canal motor barges 839
Electrical propelling machinery on the Eclipse, performance of 243
Electrically driven auxiliaries. Amercan Engineering Co..... 898
Electrically-propelled battleship Maryland, dock trials 439
Electrically propelled coast guard cutter Tampa *825
Electrically propelled freighter Biyo Maru. C. Ano *593
Electrically welded motorship Esab IV. Oscar Kjellberg *601
Electrically welded vessel, an entirely..... *277
Electricity applied to ship auxiliaries. H. L. Hibbard 463
Elsie, fishing schooner *818
Emily Deutsch De La Meurthe, tanker.... *547
Emmet, W. L. R.: Electric ship propulsion 44
Empire Arrow, oil tanker *743
Encouragement of American marine insurance. Waldon Fawcett 663
Engine construction, Diesel, innovations in. Special London Correspondent *700
Engine, Desel, crankshafts. Jos. Hecking *147
Engine, Diesel oil, new Sulzer. A. P. Chalkley *845
Engine, marine Diesel, building in Europe Special London Correspondent..... *49
Engine, oil, the Volund 470
Engine, steam, driven exciter sets..... *11
Engine, triple expansion, designed for ships of 10,000 to 12,000 deadweight tons.... 767
Engines, balancing. C. H. Peabody..*407, 477
Engines, Diesel, Germany to build high powdered. Special London Correspondent *545
Engines, Diesel, lubrication of marine. Louis R. Ford *623
Engines, Diesel, standardized. H. R. Setz. *222, 324, 391, 471, 548
Engines, Diesel, 2- versus 4-cycle. Special London Correspondent *321
Engines, internal combustion applied to propulsion. John F. Metten and J. C. Shaw *542
England's largest shipyards, one of..*105, 213
England's latest type of ocean liner, the Scythia *819
Esab IV, electrically welded motorship.... *601

Eschholz, O. H. Arc welded ships *54
Evaporator efficiency, apparatus designed to increase. Griscom-Russell Co. *816
Evaporator set. Griscom-Russell *757
Everett, H. A.: Power and speed trials of 10,000-deadweight ton tanker 910
Exciter sets, steam engine driven *11
Exeter Machine Co.: Exeter rotary pump. *686
Exhibits at marine exposition, directory of. 812
Exhibits at marine exposition (photographs) 895
Exposition, American marine week *889
Exposition, marine *809
Exposition, marine, a combined maritime gathering 733
Exposition, new devices exhibited at the marine *816, 896
Exposition, New York marine 161
Exposition, New York Marine, second.... *83
Extinguisher, Firefoam hand fire, approved by Steamboat Inspection Service *830

Fairing ships during construction. W. M. Kennedy *376
Fawcett, Waldon: Another burden proposed for shipowners 511
Fawcett, Waldon: Claims against the Government 298
Fawcett, Waldon: Current Shipping Board expenditures will influence merchant marine policy 232
Fawcett, Waldon: Encouragement of American marine insurance 663
Fawcett, Waldon: Free zones in ports... 449
Fawcett, Waldon: How the United States Government re-organization will affect the merchant marine 128
Fawcett, Waldon: New administration assumes responsibility for American merchant marine 34
Fawcett, Waldon: Reorganization of the Shipping Board 579
Fawcett, Waldon: Shipping Board gets its chance 729
Fawcett, Waldon: The effort to stamp out commercial bribery 384
Fawcett, Waldon: Transferring transport service to steamship lines 881
Fawcett, Waldon: Wage subsidy proposed for the merchant marine 803
Federal barge line: Mississippi-Warrior river towboats *435
Federal Electric Company, electric siren.. *153
Federal Electric Co.: Renewable fuses..... *541
Federal Shipbuilding Company, quantity production of Scotch marine boilers.... *443
Federal shipyard takes up ship repairing. *835
Ferris type wooden hull proves efficient lumber carrier. John J. Muir *125
Ferryboat Poughkeepsie, Diesel electric. C. V. S. Wyckoff *750
Ferryboats for Boston harbor, new..... *826
Financial statement of Shipping Board.... 878
Fire detecting system, Rich 406
Fire hazard, the marine. Frederick S. Titsworth 405
Fires, bunker 732
Fires on shipboard 887
Firefoam hand fire extinguisher approved by Steamboat Inspection Service *830
First electric coast guard cutter completed. *825
Fishermen's trophy, Canada wins *818
Fishing schooner Elsie *818
Fittings, piping, valves and flanges. Horace Holden Thayer 605
Flanges, fittings, valves and piping. Horace Holden Thayer 605
Floating crane, 60-ton, self-propelling..... *684
Floating dry dock at Gothenburg..... *445
Floating dry dock at Sparrows Point, 6,000-ton *603
Floating dry dock for testing submarines. Von Klitzing *440
Flue gas analyzer, duplex mono *656
Flying deck of H. M. S. Eagle (photograph) *375
Ford, Louis R.: Lubrication of marine Diesel engines *623
Foreign trade council, national 123
Foreign trade, financing our. George Ed. Smith 303
Foreign trade service of the Department of Commerce, Hoover reorganizes 768
Foreign trade, ship operators interested in. John L. Binda 727
Foreign trade vital to commercial future of United States 884
Foreign trade with Colombia 138
Formosa, twin screw motorship *739
Framing timbers, comparative life of woods as 705
France, merchant marine of..... 48
Free zones, in ports. Waldon Fawcett.... 449
Freeboard, rules and regulations for. David Arnott *306
Freight handling at New York Barge Terminal. Henry Cunningham, Jr. *592
Freight movements in pier transit sheds and warehouses, tractor speeds up..... *844
Freighter Thomas P. Beal *913
French passenger and mail liner Paris.... *669
Fritiof, salvage motor vessel *359
Froude hydraulic dynamometer. C. H. Peabody *244

Fuel problem for steamships. Lawrence B. Chapman 465
Fuel oil, hydraulic system for handling.... *304
Fuel oil installation, requirements for.... 146
Fuel oil, measurement of. J. D. Gilman.. 234
Fuel, semi-Diesel engines using vegetable oils as. Eugenio Normand *629
Fuller, George A., Company: tankers San Lamberto and San Leon *513
Fuses, renewable, for multiphase motors... *541

G. Harrison Smith, combination ore and oil steamer *844
Gatewood, Commander, discusses ship repairs with sea-going marine engineers... 126
Gatewood, William: the modern cargo vessel 381
Geared marine turbines. C. R. Waller.... 467
Geared turbine, marine, General Electric. C. H. Peabody *141
Geared turbine propelling equipment of the new Shawmut ships *363
Geared turbines, double reduction for merchant ships. R. J. Walker and S. S. Cook *394
Gears, reduction, for ship propulsion. Robert Warriner *532
General Electric Company: Auxiliary motors 898
General Electric Company, gas engine driven arc welding unit *621
General Electric Company, performance of electrical machinery on S. S. Eclipse ... 243
General Electric Company, steam engine driven exciter sets *11
General Electric marine geared turbine. C. H. Peabody *141
George Washington, American passenger liner *505
George Washington (interior views)..... *744
German battleship Ostfriesland, used as target for bombing tests (photograph)... *611
German ships, availability of former. Wilson P. Smith 294
Gill, P. H. & Sons Forge & Machine Works: Vacuum trap used for turbine drainage. *843
Gilman, J. D.: measurement of fuel oil... 234
Giulio Cesare, passenger steamship..... *425
Glenapp, motorship *155
Government inspection of merchant vessels. J. B. Patton 673
Governors, pump 636
Götaverken: salvage motor vessel Fritiof.. *359
Gothenburg, new floating dry dock *445
Gothenburg Towing and Salvage Company: salvage motor vessel Fritiof *359
Great Lakes commerce during July..... 687
Griscom-Russell Co.: Apparatus designed to increase efficiency *816
Griscom-Russell: Evaporator set *757
Groton Iron Works: ferryboat Lieutenant Flaherty *826
Guinevere, Diesel-electric yacht, trials of.. 728
Gyro-compass, self-steering: Anschutz & Co. *463
Gyroscope, world's largest *251

H. C. Folger, tanker *597
Hague Rules 886
Hamilton triple expansion marine engine, 3,200 indicated horsepower 767
Hamilton & Co., Ltd., William: Motorship Malia *935
Harbor facilities, marine terminals. Floyd T. Smith *66
Harbors and terminals, $700,000,000 for. H. McL. Harding *849
Harding, H. McL.: Quay steamship terminal design *635
Harland & Wolff, long stroke Diesel engine *468
Harland & Wolff, motorship Glenapp..... *155
Harland & Wolff: Passenger motorship Aba *934
Harland & Wolff: Passenger steamship Vedic *290
Harland & Wolff: Steamship Minnekahda *520
"Harold" rivet gun: American Car & Foundry Co. 896
Havelland, the motorship *847
Hawkeye State, passenger and cargo steamship *185
Hecking, Joseph: Diesel engine crankshafts *147
Hecking, Joseph: Strength of propellers.. *762
Helm or rudder angle indicator. Sperry Gyroscope Co. 817
Henry Deutsch De La Meurthe, tanker... *547
Herbert L. Pratt, tanker *597
Hess, J. L.: Mold loft suggestions ...*131, 238
Hibbard, H. L.: Electricity applied to ship auxiliaries 463
Hoist, mono-rail. Shepard Electric Crane & Hoist Co. *896
Hood Tractor Company, new tractor *844
Hook, Comrie safety *380
Hoover proposes use of idle ships in coal trade 802
Hoover reorganizes foreign trade service of Department of Commerce 768

Horne Mfg. Co.: Electrical fixtures for marine service 817
Horsepower, curves of effective. James L. Bates *678
Hose coupling, "Little David," Ingersoll-Rand Co. *96
Hovgaard, William: Calculation of transverse strength of submarines by Marbec's method. 907
How can American ships compete successfully with foreign ships? Winthrop L. Marvin 875, 905
Hull and its screw propeller, problem of C. W. Dyson *315, 398, 453, 553, 617
Hull-fin type ferryboat Poughkeepsie. C. V. S. Wykoff *750
Hull insurance, Lake 805
Hydraulic dynamometer, Froude. C. H. Peabody *244
Hydraulic system for handling fuel oil.... *304

Importance of port facilities in the development of a merchant marine and commerce. H. H. Rousseau..... 906
Index, annual, for 1921 770
Indicator, helm or rudder angle. Sperry Gyroscope Co. 817
Indicator locking device. Swan, Hunter & Wigham Richardson *769
Industrial crawling tractor crane..... *833
Industrial research laboratories 633
Influence of shape of transverse sections upon resistance. H. C. Sadler and E. M. Bragg 909
Ingersoll-Rand Co.: "Little David" hose coupling *96
Innovations in Diesel engine construction. Special London Correspondent *700
Inspection of merchant vessels, Government. J. B. Patton 673
Installation, requirements for oil fuel 146
Institution of Naval Architects meeting 228, 277, 447, 938
Insulation for refrigerator ships, Balsa... *557
Insulation for superheated steam 930
Insurance certificate 731
Insurance, developments in marine. "Bordereaux" 731, 805, 886
Insurance, encouragement of our American marine. Waldon Fawcett 663
Insurance, importance of marine. "Old Scotch." 387
Insurance rates 731
Insurance rates, via the St. Lawrence..... 732
Insurance syndicates, American marine... 40
Insurance syndicates, expansion of Syndicate A 386
Internal combustion engines applied to propulsion. John F. Metten and J. C. Shaw *542
International Mercantile Marine Company, steamship Minnekahda *520
International Mercantile Marine Company: White Star liner Majestic *735
International Petroleum Co.: Combination ore and oil steamer G. Harrison Smith. *844
Iron and steel for shipbuilding purposes. Horace Holden Thayer 370
Isherwood banquet, the 802
Isherwood system, progress of..... 130

J. E. O'Neil, tanker *597
J. Foster King-type tanker, 10,000-ton.... *12
Japan, shipbuilding in..... 59
Java, motorship *934
Johnsen, A. H.: Shipbuilding in Porto Rico 397
Joiner plans, ship *296, 368, 446, 523, 612
Jones Act, Shipping Board ready to operate under 885

Kelley, James A.: Passenger steamship Mount Clay *22
Kennecott, motorship, economical voyage from the Pacific coast to New York... *633
Kennecott, motorship, performance of. Frank Walker *780
Kennedy, W. M.: Fairing ships during construction *376
King, J. Foster, type tanker *12
Kjellberg, Oscar: Electrically welded motorship Esab IV *601
Krupp, Fried.: Motorship Zoppot..... 388

Lake hull insurance 805
Lamoriciere, passenger steamship 301
Land, Commander E. S.: American destroyer hits mine in the Baltic *139
Lane, Harold F.: Future policy of the Shipping Board 581
Lebore, ore and coal carrier *364
Leeds & Northrup Company, apparatus for measuring salinity of boiler water..... *635
Legislation, progress of shipping 687
Liability and negligence 806
Liability, shipowners 805
Lieut. Flaherty, ferryboat for Boston *826
Lifeboat davits, gravity type *323
Lighterage clause, London's new..... 887
Lighting, acetylene for ships' 587
Lighting and ventilating apparatus, marine. Pyle-National Co 816

Lighting set, Westinghouse-Sturtevant type *686
Lloyd's shipbuilding returns 157
Load line 732
Lock control of New Orleans canal *302
Lockers, plans of *368
Locking device for stockless anchors *602
Locking device, indicator, Swan, Hunter & Wigham Richardson *769
Lombard Governor Company: four cycle Diesel engine *778
London Correspondent; A review of motorship and marine Diesel engine building in Europe *49
London Correspondent: Germany to build high powered Diesel oil engines *545
London Correspondent: Innovations in Diesel engine construction *700
London Correspondent: Motorship building in Europe *155, 229, 468, 847, 933
London Correspondent: Motorship Yngaren *628
London Correspondent: Motorships not being laid up *389
London Correspondent: Two versus four cycle Diesel engines *321
Longitudinally trussed dry dock. Crandall Engineering Co. 896
Lubrication of marine Diesel engines. Louis R. Ford *623
Lubrication problem on shipboard. P. M. Robinson *458
Lucke, Charles: United States will lead in motorship building 228
Lumber and timbers for shipbuilding purposes. Horace Holden Thayer 703, 771, 840
Lumber carrier, Ferris type wooden hull proves efficient as. John J Muir *125
Lux Navigation Company, tankers delivered to *547

McAllister, C. A.: Brace up, America! Don't give up the ships!! 31
McAllister, C. A.: Proposed plans for revision of navigation laws 883
McNab Co.: Detecting salt in boiler feed water *930
Machinery, new, for Atlantic Refining tankers *597
Machinery, propelling, U. S. S. Tennessee *269
Magdalene Vinnen, motorship *933
Magnesia Association of America: Insulation for superheated steam 930
Magnesite composition decking 295
Magnetic clutch coupling. Sperry Gyroscope Co. *817
Mail and passenger liner Paris *669
Mail and passenger steamship Naldera *195
Majestic, White Star liner *735
Malaya, motorship *701
Malia, motorship. A. P. Chalkley *935
Mammoth, floating crane *591
Manning requirements, United States Shipping Board vessels 207
Manulani, cargo steamer *707
Marblehead, United States scout cruiser *274
Marine Draftsmen's convention, program of 811
Marine Decking & Supply Co.: Safety blocks 896
Marine Decking and Supply Company, magensite composition decking 295
Marine Equipment Association of America, officers and committee members (photograph) 808
Marine equipment manufacturers and shipbuilders organize 164
Marine exposition a combined maritime gathering 733
Marine exposition: American marine week a success *889
Marine exposition, first cooperative held in this country *809
Marine exposition, New York 161
Marine fire hazard. Frederick S. Titsworth 405
Marine steam practice. Eskil Berg 157
Marore, ore and oil steamship *283
Marvin, Winthrop L.: Can a shipping subsidy bill pass Congress? 725
Marvin, Winthrop L.: How can American ships compete successfully with foreign ships? *875, 905
Marvin, Winthrop L.: The Egyptian cotton controversy 655
Marvin, Winthrop L.: Why has the merchant marine act been nullified? 577
Maryland, United States battleship, dock trials 439
Maryland, United States battleship *595
Material handling: Cargo transferring, speed per linear foot *779
Material handling, efficiency in 552
Matson Navigation Company freighter Manulani *707
Measurement of fuel oil. J. D. Gilman 234
Measuring the salinity of boiler water *635
Meat cargo steamer Tairoa, British *583
Mechanical oil burning system, Coen 566
Memphis, United States scout cruiser *274
Merchant marine act, Why has it been nullified? Winthrop L. Marvin 577
Merchant marine, American, cooperation of branch banks abroad with. George E. Roberts 39
Merchant marine, American, New administration assumes responsibility for. Waldon Fawcett 34
Merchant marine, Americanization of our. "Old Scotch." 662
Merchant marine association holds convention 158
Merchant marine, effect of Government reorganization on. Waldon Fawcett 128
Merchant marine of France 48
Merchant marine, operating economy and the. R. H. M. Robinson *799
Merchant marine policy, influence of current Shipping Board expenditures on. Waldon Fawcett 232
Merchant marine, relation of, to business. Francis H. Sisson *653
Merchant marine, wage subsidy proposed for. Waldon Fawcett 803
Merchant ship auxiliaries, electric motors for. Walter E. Thau and William H. Easton *613
Merchant Shipbuilding Corporation: S. S. Mount Carroll *363
Merchant vessels, government inspection of. J. B. Patton 673
Metals and compositions, non-ferrous. Horace H. Thayer 524
Metten, John F.: Internal combustion engines applied to propulsion *542
Milwaukee, United States scout cruiser *121
Minnekahda, a ship of democracy *520
Mississippi-Warrior river towboats *435
Modasa, passenger steamship launched 167
Modern anglesmithing. Maurice Nicholls *135
Modern cargo vessel. William Gatewood 381
Modern methods of casting propellers *696
Mold loft suggestions. J. I. Hess *131, 238
Molding material eliminates blow holes in Thermit welding 695
Mono-rail hoist. Shepard Electric Crane & Hoist Co. *896
Moore shipyard, railway dry docks at *759
Motor Boat Show, 16th annual 21
Motor passenger liner Aba *934
Motors, electric, for merchant ship auxiliaries. Walter E. Thau and William H. Easton *613
Motors, marine auxiliary. General Electric Co. 898
Motors, multiphase, renewable fuses for. Federal Electric Co. *541
Motors, winch, of the motorship William Penn. G. A. Pierce *831
Motorship building in Europe. London correspondent *49, 155, 229, 468, 776, 847, 933
Motorship building in the United States 46
Motorship building, United States leadership predicted. Dr. C. E. Lucke 228
Motorship Conde de Churruca *776
Motorship Esab IV, electrically welded. Oscar Kjellberg *601
Motorship Formosa, twin screw *739
Motorship Glenapp *155
Motorship Havelland *847
Motorship Java *934
Motorship Kennecott, economical voyage from the Pacific coast to New York *633
Motorship Kennecott, performance of. Frank Walker *780
Motorship Kobenhavn *933
Motorship Magdelene Vinnen *933
Motorship Malaya *701
Motorship Malia. A. P. Chalkley *935
Motorship Narragansett, 10,000-ton tanker *16
Motorship, salvage, Fritiof *359
Motorship Tosca *280
Motorship William Penn, winch motors on. G. A. Pierce *831
Motorship Yngaren. Special London Correspondent *628
Motorship Zoppot, notes on the German 388
Motorships 802
Motorships, air compressors for 930
Motorships, electric siren for *153
Motorships not being laid up. Special London Correspondent *389
Mount Clay, passenger steamship. James A. Kelly *22
Mount Carroll, passenger and cargo steamship *363
Muir, John J.: Ferris type wooden hull proves efficient lumber carrier *125
Munson liner, Aeolus, re-conditioned. H. G. Crosby *1

Naldera, passenger and mail steamship *195
Narragansett, 10,000-ton motor tanker *16
Natchez, Mississippi-Warrior river towboat *435
National Association of Engine and Boat Manufacturers, 16th annual Motor Boat Show 21
National foreign trade council 123
National Merchant Marine Association holds convention 158
Naval Architects' annual meeting *661, 810, 899
Naval Architects' meeting in London 228, 277, 447
Naval Architects Society, spring meeting of 415
Navigation laws, revision of. C. A. McAllister 883
Navigazione Generale Italiana: Passenger liner Giulio Cesare *425
Negligence and liability 806
Nelly Lasry, wine steamer *360
New Orleans canal, lock control of *302
New York and Porto Rico Steamship Co.: Passenger and cargo vessel San Lorenzo *430
New York Barge Terminal, freight handling at. Henry Cunningham, Jr. *592
New York Blue Print Paper Company, parallel ruling attachment *167
New York Marine Exposition *83, 161, 889
New York Shipbuilding Corporation: Oil tanker Empire Arrow *743
New York Shipbuilding Corporation: Passenger steamship Wenatchee *438
New York Shipbuilding Corporation: U. S. battleship Washington *752
Newington Steam Trawler Company, Ltd.: trawler Rudyard Kipling *665
Newport News Shipbuilding & Dry Dock Company, arc welding equipment *406
Newport News Shipbuilding and Dry Dock Company: Battleship Maryland *595
Newport News Shipbuilding and Dry Dock Company, dock trials of U. S. S. Maryland 439
Newport News Shipbuilding and Dry Dock Company, U. S. battle cruiser Ranger *439
News, marine construction 101, 181, 265, 347, 421, 494, 570, 644, 718, 791, 867, 943
News, shipping and ship operation 713, 785, 861, 939
News, shipbuilding *95, 177, 261, 342, 417, 491, 567, 641, 717, 788, 864, 940
Newton, cubist steamship *119
Nicholls, Maurice: Modern anglesmithing *135
Nicholls, Maurice: Relation of tools to building berths *378
Non-ferrous metals and compositions. Horace H. Thayer 524
Non-ferrous metals: Scoville Mfg. Co. *896
North British Diesel Engine Works, Ltd., Diesel engine *468
Northern Fire Apparatus Co.: Rotary pump 896
Notations, bill of lading 806
Notes on operation of turbines. E. H. B. Anderson 445

Oil and ore steamer G. Harrison Smith *844
Oil, bunker, RanD system for 314
Oil burners, Peabody-Fisher 912
Oil burning system, Coen mechanical 566
Oil engine building in Europe. London Correspondent *49
Oil engine construction, Diesel, innovations in. London Correspondent *700
Oil engine, Lombard 4-cycle *778
Oil engine, new Sulzer. A. P. Chalkley *845
Oil engine, Still *468
Oil engine, Volund 470
Oil engines, Diesel, Germany to build high powered. London Correspondent *545
Oil engines, Diesel, lubrication of marine. Louis R. Ford *623
Oil engines, Diesel, 2 versus 4 cycle. Special London Correspondent *321
Oil engines, semi-Diesel, using vegetable oils as fuel. Eugenio Normand *629
Oil engines, standardized, Diesel. H. R. Setz *222, 324, 391, 471, 548
Oil fuel, hydraulic system for handling *304
Oil fuel installation, requirements for 146
Oil separator, Babcock & Wilcox *156
Oil tank motorship Narragansett, 10,000-ton *16
Oil tank steamship, 10,000-ton *12
Oil tanker Empire Arrow *743
"Old Scotch": Americanization of our merchant marine 662
"Old Scotch": Are you a shipping man a la Edison 807
"Old Scotch": Catch the bees 300
"Old Scotch": Economy, economy and yet more economy 177
"Old Scotch": Importance of marine insurance 387
"Old Scotch": Questions for marine engineers, Edison standard 588
"Old Scotch": Shipping Board, how it can economize 231
"Old Scotch": What are we carrying? 451
Omaha, United States scout cruiser *121
Operating economy of the merchant marine. R. H. M. Robinson *799
Operation, present indications regarding ship. Robert E. Annin 879
Ore and coal carriers Chilore and Lebore *364
Ore and oil steamer G. Harrison Smith *844
Ore and oil steamers Marore and Steelore *283
Oropesa, passenger and cargo steamship *351

P. and O. liner Naldera *195
Pacific Steam Navigation Company: Steamship Oropesa *351
Panama canal, commerce through in 1920 *392
Panama canal tolls exemption, Senate vote for. Winthrop L. Marvin 800
Parallel ruling attachment for drawing boards 167
Paris, passenger and mail liner *669
Passenger and cargo steamer Oropesa *351
Passenger and cargo steamship Hawkeye State *185

Passenger and cargo steamship Mount Carroll ... *363
Passenger and cargo vessel San Lorenzo ... *430
Passenger and mail liner Paris ... *669
Passenger and mail steamship Naldera ... *195
Passenger liner George Washington ... *505
Passenger liner Giulio Cesare ... *425
Passenger liner Minnekahda ... *520
Passenger liner Wenatchee ... *438
Passenger motorship Aba ... *934
Passenger ship for French line, new ... 301
Passenger steamer George Washington (interior views) ... *744
Passenger steamer Modasa launched ... 167
Passenger steamship Aeolus, re-conditioned. H. G. Crosby ... *1
Passenger steamship Majestic ... *735
Passenger steamship Mount Clay. James A. Kelley ... *22
Passenger steamship Samaria ... *115
Passenger steamship Vedic ... *290
Patton, J. B.: Government inspection of merchant vessels ... 673
Pawling and Harnischfeger: Tilting and rotary table for use with boring and drilling machines ... *690
Peabody, C. H.: Balancing engines ... *407, 477
Peabody, C. H.: Froude hydraulic dynamometer ... *244
Peabody, C. H.: General Electric marine geared turbine ... *141
Peabody, C. H.: Naval architects meeting in London ... 447
Peabody, C. H.: Ships and their construction ... 42
Peabody, C. H.: Superheated steam on steamships ... *539
Peabody-Fisher oil burners ... 912
Pensacola dry dock, floating ... *329
Pensacola Shipbuilding Company: Tug Adler ... *747
Performance of the motorship Kennecott. Frank Walker ... *780
Petroleum specifications, standardization of 237
Pierce, G. A.: Winch motors of the motorship William Penn ... *831
Piers at Staten Island, new. Floyd T. Smith ... *247
Pilferage and theft ... 732
Pipes, list of, comprising steam and exhaust system on Thomas P. Beal ... *918
Piping systems, ships', table of requirement 608
Piping, valves, flanges and fittings. Horace Holden Thayer ... 605
Planing machine, close quarter. Swan, Hunter & Wigham Richardson, Ltd. ... *754
Plumbing fixtures, weights of various ... 117
Port facilities, marine terminals. Floyd T. Smith ... *66
Portable belt conveyor used at Tampa for coaling ships ... *837
Portable tools, relation of, to building berths. Maurice Nicholls ... *378
Porto Rico, shipbuilding in. A. H. Johnsen 397
Ports, free zones in. Waldon Fawcett ... 449
Poughkeepsie, Diesel-electric ferryboat. C. V. S. Wyckoff ... *750
Power and speed trials of 10,000-deadweight ton tanker. H. A. Everett ... 910
Premium for transshipments ... 886
Present indications regarding ship operation. Robert E. Annin ... 879
Problem of the hull and its screw propeller, C. W. Dyson ... *315, 398, 453, 553, 617
Program of Marine Draftsmen's convention *811
Program of Naval Architects' meeting ... 810
Progress of motorship building in Europe. London Correspondent ... *933
Progress of shipbuilding in the United States ... 165
Progress of shipping legislation ... 687
Progress of welding in the shipyards. William T. Bonner ... *57
Propeller, problem of the hull and. C. W. Dyson ... *315, 398, 453, 553, 617
Propeller repair job, two notable features in ... *604
Propellers, modern methods of casting ... *696
Propellers, strength of. Joseph Hecking ... *762
Propelling machinery of U. S. S. Tennessee *269
Propelling machinery, selection of. Lawrence B. Chapman ... 691
Propulsion, electric ship. W. L. R. Emmet 44
Propulsion, international combustion engines applied to. John F. Metten and J. C. Shaw ... *542
Propulsion of ships, electric. W. E. Thau *925
Propulsion, reduction gears for. Robert Warriner ... *532
Pump, Exeter rotary. Exeter Machine Co. *686
Pump governors, turbine and reciprocating 636
Pump, rotary: Northern Fire Apparatus Co. ... 896
Pump, rotary geared. Arrow Pump Co. ... *708
Pump, valveless reciprocating. Clinton Dry Docks ... 898
Pyle-National Company: Marine lighting and ventilating apparatus ... 816

Quantity production of Scotch marine boilers ... *443
Quay steamship terminal design. H. McL. Harding ... *635
Questions for a shipping man, a la Edison. "Old Scotch." ... 807
Questions for marine engineers, Edison standard. "Old Scotch." ... 588, 755

Radio compass on shipboard ... *620
Radio station, Easthampton ... *38
Railway drydocks at the Moore shipyard ... *759
Raleigh, United States scout cruiser ... *274
Ralph J. Palumbo, ferryboat for Boston ... *826
RanD system for bunker oil ... 314
Random notes by an old seaman. Capt. R. E. Barry ... *137, 688
Ranger, United States cruiser ... *439
Rates, insurance ... 731
Rates, insurance via the St. Lawrence ... 732
Reciprocating and turbine pump governors 636
Recorder, continuous course and speed. Sperry Gyroscope Co. ... *817
Reduction gears, double, for merchant ships. R. J. Walker and S. S. Cook ... *394
Reduction gears for ship propulsion. Robert Warriner ... *532
Reduction gears, turbine, versus electric propulsion. Eskil Berg ... 390
Refrigerator and cargo steamer City of Pekin ... *657
Refrigerator ships, Balsa insulation for ... *557
Relation of our merchant marine to business. Francis H. Sisson ... *653
Relation of portable tools to building berths. Maurice Nicholls ... *378
Renewable fuses for multiphase motors. Federal Electric Co. ... *541
Repair facilities in the United States ... *72
Repair job, propeller ... *604
Repair, notable wartime ... *393
Repair plants, ship, of the United States, (table) ... 76
Repairing, Federal shipyard takes up ship *835
Repairs, Commander Gatewood discusses with sea-going engineers ... 126
Review of motorship and marine Diesel engine building in Europe. London Correspondent ... *49
Rich system of fire detecting ... 406
Richmond, United States scout cruiser ... *274
Rigg, E. H.: Design and construction of passenger steamers ... 908
Rim-Lok guard for watertight electrical fixtures. Horne Mfg. Co. ... *817
River and Ocean-Towing Co.: Tug Adler. *747
Rivet gun, "Harrold": American Car & Foundry Co. ... 896
Roberts, George E.: Branch banks abroad —Their ability to cooperate with an American merchant marine ... 39
Robins Dry Dock and Repair Company, S. S. San Lorenzo ... *430
Robinson, P. M.: Lubrication problem on shipboard ... *459
Robinson, R. H. M.: Operating economy and the merchant marine ... *799
Rodgers, W. L.: Tactical relations between different classes of men-of-war and their embodiment in design ... 900
Rotary geared pump for cooling marine engines. Arrow Pump Co. ... *708
Rotary pump: Northern Fire Apparatus Co. ... 896
Rousseau, H. H.: Importance of port facilities in the development of a merchant marine and commerce ... 906
Row and Davis, Inc., bunker oil system ... 314
Rudder angle indicator. Sperry Gyroscope Co. ... 817
Rudders and rudder design ... *137
Rudyard Kipling, steam trawler ... *665
Rules and regulations for freeboard. David Arnott ... *306
Ruling attachment, parallel, for drawing boards ... *167

S-48, United States submarine launched at Bridgeport ... *273
Sadler, H. C.: Influence of shape of transverse section upon resistence ... 909
Safety blocks, Marine Decking & Supply Co. 896
Safety hook, Comrie ... *380
Salinity of boiler water, apparatus for measuring ... *635
Salt detector, boiler feed water ... *930
Salvage association organized ... 887
Salvage motor vessel Fritiof ... *359
Samaria, new Cunarder ... *115
San Lamberto, tanker ... *513
San Leon, tanker ... *513
San Lorenzo, cargo and passenger vessel ... *430
Schooner yacht America (photograph) ... *934
Schultz, Heinrich: Approximate stability formulae ... *481
Schulze, H. H.: Cost accounting and estimating ... 907
Scotch marine boilers, quantity production *443
Scout cruisers. Lieut.-Commander D. F. Ducey ... *274
Scout cruisers, United States ... *121
Scoville Mfg. Co.: Non-ferrous metals ... *896
Scythia, latest type of ocean liner ... *819
Sea-going tug Adler ... *747
Searchlights, miniature ... 406
Seattle port commissioners propose automatic cargo handling ... *166
Selection of propelling machinery. Lawrence B. Chapman ... 691
Self-propelling floating crane, 60-ton ... *684
Semi-Diesel engines using vegetable oils as fuel. Eugenio Normand ... *629

Separator, oil, Babcock & Wilcox ... *156
Service blowers. B. F. Sturtevant Co. ... *896
Setz, H. R.: Standardized Diesel engines *222, 324, 391, 471, 548
Shallow draft vessel, new type of ... *538
Shaw, J. C.: Internal combustion engines applied to propulsion ... *542
Shaw, Savill & Albion Steamship Company, Ltd.: Meat carrier Tairoa ... *583
Shawmut ships, geared turbine propelling equipment of ... *363
Shear, turret rotary, for cutting metal without swinging the stock. Southwark Foundry & Machine Co. ... *767
Shepard Electric Crane & Hoist Co.: Mono-rail hoist ... *896
Ship and engine control, Sperry develops new device for. Sperry Gyroscope Co. ... *817
Ship operation, economy in. "Old Scotch" 127
Ship propulsion, electric. W. L. R. Emmet 44
Ship operators interested in foreign trade. John L. Binda ... 727
Ship operation, present indications regarding. Robert E. Annin ... 879
Ship repairs, Commander Gatewood discusses with sea-going marine engineers ... 126
Ships and their construction. C. H. Peabody ... 42
Ships, Brace up America! Don't give up the!! C. A. McAllister ... 31
Ships, electrical propulsion of. W. E. Thau *925
Shipboard fires ... 887
Shipbuilding, American—present and future *25
Shipbuilding and marine news ... *95, 177, 261, 342, 417, 491, 567, 641, 717, 788, 864, 940
Shipbuilding in Japan ... 99
Shipbuilding in Porto Rico. A. H. Johnsen 397
Shipbuilding, motor, increases in Europe. Special London Correspondent ... *468
Shipbuilding, progress of, in the United States ... 165
Shipbuilding returns, Lloyd's ... 157
Shipbuilding, timbers and lumber for. Horace Holden Thayer ... 703, 771, 840
Shipbuilding, steel and iron for. Horace Holden Thayer ... 370
Shipbuilding, substitutes for natural wood for. Horace Holden Thayer ... 931
Shipowners, another burden proposed for. Waldon Fawcett ... 511
Shipowners' liability ... 805
Shipping, American Bureau of ... 37
Shipping, American, gaining strong position in north transpacific commerce ... *768
Shipping and ship operation news ... 713, 785, 861, 939
Shipping Board, back up the new ... *501
Shipping Board, financial statement of ... 878
Shipping Board, future policy of the. Harold F. Lane ... 581
Shipping Board gets its chance. Waldon Fawcett ... 729
Shipping Board, how it can economize. "Old Scotch." ... 231
Shipping Board, new Chairman of ... *503
Shipping Board ready to operate under Jones act ... 885
Shipping Board, recent activities of the ... 855
Shipping Board, reorganization of. Waldon Fawcett ... 579
Shipping Board steamers, regular commercial schedules ... 878
Shipping Board steamship Hawkeye State ... *185
Shipping, cost of Danish ... 146
Shipping: How can American ships compete? Winthrop L. Marvin ... 875
Shipping legislation introduced in Congress 936
Shipping legislation, progress of ... 578, 687
Shipyard at Tacoma, Todd Corporation ... *921
Shipyard, Federal, takes up ship repairing. *835
Shipyard, Moore, railway dry dock ... *759
Shipyards at Danzig active ... *599
Shipyards, one of England's largest. *105, 213
Shipyards, progress of welding in the. William T. Bonner ... *57
Sidney Lasry, wine steamer ... *360
Siren, electric, for motorships ... *153
Sisson, Francis H.: Relation of our merchant marine to business ... *653
Smith, Floyd T.: Marine terminals and port facilities ... *66
Smith, Floyd T.: New piers at Staten Island ... *247
Smith, George Ed.: Financing our foreign trade ... 303
Smith, Wilson P.: Availability of the ex-German ships ... 294
Society of marine draftsmen, membership campaign under way for ... 251
Society of Naval Architects, annual meeting ... *661, 899
Southwark Foundry & Machine Co.: Turret rotary shear for cutting metal without swinging the stock ... *767
Sperry Gyroscope Co.: Continuous course and speed recorder ... *817
Sperry Gyroscope Co.: Helm or rudder angle indicator ... 817
Sperry Gyroscope Co.: Magnetic clutch coupling ... *817
Sperry Gyroscope, the world's largest ... *251
Stability formulae, approximate. Heinrich Schultz ... *481

Standard Transportation Company: Oil tanker Empire Arrow *743
Standardization of petroleum specifications. 237
Standardized Diesel engines. H. R. Setz. *222, 324, 391, 471, 548
Starter, automatic, for squirrel cage motors. Cutler-Hammer Mfg. Co. *775
Staten Island piers, new. Floyd T. Smith. *247
Steam engine driven exciter sets..... *11
Steam, marine practice. Eskil Berg..... 157
Steam velocity and steam flow tables. V. F. Davis 522
Steamer, ore and oil, G. Harrison Smith... *844
Steamship Aeolus re-conditioned. H. G. Crosby *1
Steamship, cable, All America..... *207
Steamship, cargo, Biyo Maru. C. Ano... *593
Steamship, cargo, Manulani *707
Steamship, cargo, Tairoa..... *583
Steamship Eclipse, exciter sets of *11
Steamship Eclipse, performance of 243
Steamship, freighter, Thomas P. Beal..... *913
Steamship George Washington (interior views) *744
Steamship lines, transferring transport service to. Waldon Fawcett 881
Steamship Newton, cubist *119
Steamship Oropesa, passenger and cargo... *351
Steamship, passenger and cargo, Hawkeye State *185
Steamship, passenger and cargo, Mount Carroll *363
Steamship, passenger and mail, Naldera.... *195
Steamship, passenger and mail, Paris..... *669
Steamship, passenger, George Washington. *505
Steamship, passenger, Giulio Cesare..... *425
Steamship, passenger, Lamoriciere..... 301
Steamship, passenger, Modasa, launched... 167
Steamship, passenger, Majestic..... *735
Steamship, passenger, Minnekahda..... *520
Steamship, passenger, Mount Clay. James A. Kelley *22
Steamship, passenger, Wenatchee..... *438
Steamship, refrigerator and cargo, City of Pekin *657
Steamship San Lorenzo *430
Steamship Samaria *115
Steamship Scythia *819
Steamship, tanker, Empire Arrow *743
Steamship, tanker, H. C. Folger *597
Steamship, tanker, Herbert L. Pratt *597
Steamship, tanker, J. E. O'Neil *597
Steamship, tanker, W. M. Irish *597
Steamship, tanker, 10,000-ton *12
Steamship, tanker, W. M. Burton *597
Steamship, the modern cargo. William Gatewood 381
Steamship, trawler, Rudyard Kipling..... *665
Steamship Vedic *290
Steamship Ville de Dannemarie, launch of.. 71
Steamships, availability of former German. Wilson P. Smith 294
Steamships Chilore and Lebore, ore and coal carriers..... *364
Steamships, fuel problem for. Lawrence B. Chapman 465
Steamships Marore and Steelore, ore and oil *283
Steamships, tankers, Henry Deutsch de La Meurthe and Emily Deutsch De La Meurthe *547
Steamships, tankers, new machinery for Atlantic Refining *597
Steamships, tankers, San Lamberto and San Leon *513
Steamships, wine, Nelly Lasry and Sidney Lasry *360
Steel and iron for shipbuilding purposes. Horace Holden Thayer. 370
Steelore, ore and oil steamship *283
Steering gear, combined screw and spring quadrant type *685
Steering gear, electric, on Standard Oil barges *15
Still combined steam and oil engine..... *468
Still Diesel engine *545
Strength of propellers. Joseph Hecking... *762
Sturtevant Co., B. F.: special service blowers *896
Submarine S-48 launched at Bridgeport... *273
Submarines, floating dry dock for testing. Von Klitzing *440
Subsidy bill for shipping, can it pass Congress? Winthrop L. Marvin..... 725
Subsidy proposed for the merchant marine, wage. Waldon Fawcett 803
Substitutes for natural wood for shipbuilding purposes. Horace Holden Thayer ... 931
Successful "American Marine Week" assured *809
Sulzer Diesel engine..... *545
Sulzer Diesel engine, new. A. P. Chalkley. *845
Sulzer engine, special features of *777
Sulzer two-cycle Diesel engine..... *321
Superheated steam, insulation for 930
Superheated steam on steamships. C. H. Peabody *539
Supplement: Assembly of two-plane, double reduction type marine geared turbine, General Electric *142-A
Supplement: Boiler room piping and arrangement plans, steamship Naldera .. *202-A
Supplement: Deck plans, British frozen meat cargo steamer Tairoa..... *584-B
Supplement: Deck plans George Washington *508-B
Supplement: Deck plans of liner Scythia *820-B
Supplement: Deck plans, motorship Tosca *280-B
Supplement: Deck plans, steamer City of Pekin *658-B
Supplement: Deck plans, steamship Aeolus *118-B
Supplement: Deck plans steamship Hawkeye State *190-B
Supplement: Deck plans S. S. Mount Clay *22-B
Supplement: Deck plans, steamship Oropesa *356-B
Supplement: Deck plans 10,000-ton tanker *12-B
Supplement: General layout of Armstrong yard, England *108-A
Supplement: Inboard profile and deck plans S. S. Mount Clay..... *22-A
Supplement: Layout of platers shop, Armstrong yard, England..... *108-B
Supplement: Midship section, passenger liner Giulio Cesare *428-A
Supplement: Profile and deck plans of liner Scythia *820-A
Supplement: Profile and deck plans, motorship Tosca *280-A
Supplement: Profile and deck plans, ore and oil steamers Marore and Steelore *284-A
Supplement: Profile and deck plans steamship Aeolus *118-A
Supplement: Profile and upper deck plans steamship George Washington..... *508-A
Supplement: Profile and deck plans steamship Hawkeye State *190-A
Supplement: Profile and upper decks, steamship Oropesa *356-A
Supplement: Profile and deck plans 10,000-ton tanker *12-A
Supplement: Profile and deck plans, wine steamers Nelly Lasry and Sidney Lasry *360-A
Supplement: Profile and upper decks, British frozen meat cargo, steamer Tairoa *584-A
Supplement: Profile and weather deck plans, steamer City of Pekin..... *658-A
Supplement: Standardized Diesel engines *224-A
Supplement: Standardized Diesel engines *472-A
Supplement: Standardized Diesel engines *548-A
Survey fees, new Board of Trade..... 437
Sweat damage 806
Swan, Hunter and Wigham Richardson, Ltd.: Passenger liner Giulio Cesare.. *425
Swan, Hunter and Wigham Richardson, Ltd.: passenger ship Lamoriciere..... 301
Swan, Hunter & Wigham Richardson, Ltd.: passenger steamship Modasa..... 167
Swan, Hunter & Wigham Richardson, Ltd., cable steamer All America..... *207
Swan, Hunter & Wigham Richardson, Ltd.: Close quarter deck planing machine *754
Swan, Hunter & Wigham Richardson: Indicator Locking Device..... *769

Table, titling and rotary, for use with boring and drilling machines. Pawling and Harnischfeger Co..... *690
Table of comparative life of woods as framing timbers 705
Tables, steam velocity and flow. V. F. Davis 522
Tactical relations between different classes of men-of-war and their embodiment in design. W. L. Rodgers, U. S. N..... 900
Tairoa, British frozen meat cargo steamer. *583
Tampa, electrically propelled Coast Guard Cutter, ... *825
Tams, Lemoine & Crane design wooden tug for tropics..... *279
Tanker, H. C. Folger..... *597
Tanker, Herbert L. Pratt..... *597
Tanker, J. E. O'Neil..... *597
Tanker: Narragansett, 10,000-ton motorship *16
Tanker, new design of 10,000-ton..... *12
Tanker, oil, Empire Arrow..... *743
Tanker W. M. Burton..... *597
Tanker, W. M. Irish..... *597
Tankers delivered to Lux Navigation Co.. *547
Tankers, new machinery for Atlantic Refining *597
Tankers San Lamberto and San Leon... *513
Tennessee, United States battleship..*269, 513
Terminal design, quay steamship. H. McL. Harding *635
Terminal, New York barge, freight handling at. Henry Cunningham, Jr..... *592
Terminals and harbors, $700,000,000 for H. McL. Harding..... *849
Terminals and port facilities, marine. Floyd T. Smith..... *66
Thau, Walter E.: Electric motors for merchant ship auxiliaries..... *613
Thau, W. E.: Electric propulsion of ships *901, 925
Thayer, Horace H.: Non-ferrous metals and compositions..... 524
Thayer, Horace Holden: Piping, valves, flanges and fittings..... 605
Thayer, Horace Holden: Steel and iron for shipbuilding purposes 370
Thayer, Horace Holden: Substitutes for natural wood for..... 931
Thayer, Horace Holden: Timbers and lumber for shipbuilding purposes 703, 771, 840
The most interesting job in the yard *761, 838
Theft and pilferage..... 732
Thermit welding, molding material eliminates blow holes in..... 695
Thomas P. Beal, steam freighter..... *913
Thornycrofts launch their third post-war steamer 71
Tilting and rotary table for use with boring and drilling machines. Pawling and Harnischfeger Co..... *690
Timbers and lumber for shipbuilding purposes. Horace Holden Thayer..703, 771, 840
Titsworth, Frederick S.: the marine fire hazard 405
Todd Corporation's shipyard at Tacoma... *921
Tolls exemption, Panama Canal, the senate vote for. Winthrop L. Marvin..... 800
Tools, portable, relation of to building berths. Maurice Nicholls..... *378
Torpedo boat destroyer, American, hits mine in Baltic. Commander E. S. Land *139
Tosca, motorship *280
Towboat Natchez, Mississippi-Warrior river *435
Tractor speeds up freight movements in pier transit sheds and warehouses..... *844
Transferring transport service to steamship lines. Waldon Fawcett..... 881
Transoms, plans of..... *446
Transport service, transferring of to steamship lines. Walden Fawcett..... 881
Transshipment premiums 886
Trap, vacuum, used for turbine drainage. P. H. Gill & Sons Forge & Machine Works *843
Trawler, steam, Rudyard Kipling..... *665
Trenton, United States scout crusier..... *274
Trial trip of the United States battleship Tennessee *513
Triple expansion engine designed for ships of 10,000 to 12,000 deadweight tons... 767
Tug Adler, sea-going, 792 tons..... *747
Tug, wooden, for service in tropics..... *279
Turbine and reciprocating pump governors 636
Turbine, geared, propelling equipment of Shawmut ships *363
Turbine, marine geared, General Electric. C. H. Peabody *141
Turbine reduction gears versus electric propulsion. Eskil Berg 390
Turbines, marine geared. C. R. Waller.. 467
Turbines, notes on operation of. E. H. B. Anderson 445
Turret rotary shear for cutting metal without swinging the stock. Southwark Foundry & Machine Co..... *767
Twin screw motorship Formosa..... *739

United States battle cruiser Ranger..... *439
United States battleship California (photograph) *754
United States battleship Colorado (photograph) *433
United States battleship Maryland..... *595
United States battleship Maryland, dock trials 439
United States battleship Tennessee, final trials *513
United States battleship Tennessee, propelling machinery *269
United States battleship Washington..... *752
United States destroyers, performance of recent *209
United States scout cruisers..... *121
United States scout cruisers. Lieut. Commander D. F. Ducey..... *274
United States Shipping Board vessels, manning requirements of 207
United States submarine S-48..... *273
Unrepaired damage..... 806

Vacuum trap used for a turbine drainage. P. H. Gill & Sons Forge & Machine Works *843
Valveless reciprocating pump. Clinton Dry Docks 898
Valves, flanges, fittings and piping. Horace Holden Thayer 605
Varnish, Valspar, combined with transparent color. The Valentine Co..... 816
Vedic, 3rd class passenger carrier..... *290
Vegetable oils as fuel in semi-Diesel engines. Eugenio Normand..... *629
Vickers, Ltd., Diesel engine..... *389, 700
Vickers, Ltd.: motorship Narragansett... *16
Vickers, Ltd., steamship Scythia..... *819
Vickers-Petters Diesel engine..... *321
Victor Engineering Co.: ash ejector *816, 929
Ville de Dannemarie, launch of steamship. 71
Volund heavy oil engine..... 470
Von Klitzing: Floating dry dock for testing submarines..... *440

W. M. Burton, tanker..... *597
W. M. Irish, tanker..... *597
Wage subsidy proposed for the merchant marine. Waldon Fawcett..... 803
Walker, Frank: Performance of the motorship Kennecott *780

Walker, R. J.: Double reduction gears for merchant ships ... 394
Waller, C. R.: Geared marine turbines.. 467
Ward Engineering Works, Charles; towboat Natchez ... *435
Wardrobes, plans of ... *368
Warriner, Robert: Reduction gears for ship propulsion ... *532
Washington, United States battleship.... *752
Wayne Tool Mfg. Co.: Chuck for holding broken drill shanks ... *633
Weather doors, plans of ... *612
Webster, F. B.: Broadening the use of welding in shipbuilding ... *852
Weight allowances ... 140
Weights of various plumbing fixtures.... 117
Welded, electrically, motorship Esab IV. Oscar Kjellberg ... *601
Welds, rudder frame, allowing for construction while making ... 480
Welded ships, arc. O. H. Eschholz ... *54
Welded vessel, electrically ... *277
Welding, arc, equipment at Newport News yard ... *406
Welding in shipbuilding, broadening the use of. F. B. Webster ... *852
Welding in the shipyards, progress of. William T. Bonner ... *57
Welding plant, electric, mounted on motor truck ... *56
Welding, Thermit, molding material eliminates blow holes in ... 695
Welding units, gas engine driven electric *621
Welding work (electric arc) record of, Bethlehem Shipbuilding Corporation ... *61
Wellman-Seaver-Morgan Company, dry dock capstan ... *622
Wenatchee, passenger steamship ... *438
Werkspoor Diesel engine ... *229
Westinghouse Electric & Manufacturing Company, propelling machinery of U. S. Tennessee ... *269
Westinghouse-Sturtevant: Lightweight engine generator set for marine auxiliary service ... *686
What are we carrying? "Old Scotch".. 451
Wheeler, C. H., Mfg. Co., Froude hydraulic dynamometers ... *244
White Star Line passenger steamship Vedic ... *290
White Star liner Majestic ... *735
Winch motors of the motorship William Penn. G. A. Pierce ... *831
Wine steamers Nelly Lasry and Sidney Lasry ... *360
Winnisimet Shipyard, Inc.: Ferryboat Ralph J. Palumbo ... *826
Wireless regulations, new, for vessels in British ports ... 45
Wooden hull, Ferris type, proves efficient lumber carrier. John J. Muir ... *125
Wooden tug for service in tropics ... *279
Wyckoff, C. V. S.: Diesel-electric ferryboat Poughkeepsie ... *750

Yacht Guinevere, trials of ... 728
Yard, the most interesting job in.. *761, 838
Yarrow skimming boat ... *538
Yngaren, motorship. Special London Correspondent ... *628

Zones, free in ports. Walden Fawcett.... 449
Zoppot, motorship, notes on the German 388

COMMUNICATIONS

Are you a marine engineer, Edison standard? Charles J. Mason ... 712

Brake horsepower, determination of. C. F. Scott ... 413

Cost of Shipping Board building rentals in Philadelphia. W. J. Bollenbeck ... 335

Data sheets, appreciates. R. P. Tobin.... 712
Derivation of formulæ in paper on double reduction gears for merchant ships. James L. Haynes ... 565
Diesel electric drive for low powered cargo vessels. William Mulheron ... 171

Economical cargo ship. A. J. C. Robertson. 255
Economical cargo ship. C. H. Peabody.... 255
Electric drive, Diesel, for low powered cargo vessels. William Mulheron ... 171
Electric vs. geared turbine drive in merchant vessels. Percy Day ... 255
Electrically driven passenger ship, first. Gösta Hartzell ... 88
Engine, first triple expansion, built in United States still in service ... 858
Engineers, sea-going, attitude of. Bert L. Todd ... 255

Filters in lubricating systems for geared turbines. Benjamin G. Fernald ... 88

Joint packing on fuel oil heater line. Jack Harrington ... 88

Lighting sets, should direct or alternating current be used for. C. Hibbard ... 858
Lubricating systems for geared turbines, filters in. Benjamin G. Fernald ... 88

Marine exposition, New York. C. H. Peabody ... 413
Motorboat standards. Ira Hand ... 413

Packing, joint, on fuel oil heater line. Jack Harrington ... 88

Shipping Board building rentals, cost of in Philadelphia. W. J. Bollenbeck ... 335
Superheated steam on steamships. James L. Haynes ... *640

Turbine drive in merchant vessels, comparison of electric with geared. Percy Day ... 255

Webb Institute of Naval Architecture. Edwin T. Day ... 858

EDITORIALS

Action demanded of new administration, immediate ... 332
Administrator necessary, a real ... 484
Admiral Benson ... 332
Air service ... 170
America not over supplied with ships ... 253
Appropriations, Shipping Board ... 652

Bare-boat charter ... 722
Battleship, essentials of a ... 253
Brake horsepower, determination of ... 254
Butler bill, the ... 795
Buy ships now ... 499
Buyers marking time ... 649

Charter, bare-boat ... 722
Construction, operation has helped carry... 723
Contracts, Government ... 649
Cost per ton, operating ... 722
Criticism ... 650

Determination of brake horsepower ... 254
Disarmament ... 500
Discrimination ... 796

Economy and the naval program ... 723
Employment bureau for engineers ... 650
English recognition of Mr. Schwab ... 650
Engineer, the naval ... 254
Engineers for political positions ... 334
Engineers, employment bureau for ... 650
Enlarging our scope ... 649
Essentials of a battleship ... 253
Exposition, marine ... 723
Expositions, marine ... 169

Foreign trade and shipping ... 796
Foreign trade, our ... 332
Foreign Trade Financing Corporation ... 253
Foreign trade policy needed ... 724

Gas turbine, the ... 485
Government contracts ... 649
Government ownership versus subsidy ... 168

I. M. M. hearings ... 797
Immigration in American vessels ... 486
Index, annual, order your copy now ... 795
Insurance, marine ... 87
Insurance, reduced ... 651
Internal combustion steam power ... 651

Joiner work, standardizing ... 412

Labor saving tools in England ... 169
Leviathan, the ... 721
Lighthouse service, vessels for ... 576
Lighthouse service, vessels urgently needed for ... 410
Lloyd's Registry, returns of ... 652
Load line ... 87

Manning requirements ... 253
Marine Engineering broadening its policy.. 649
Marine exposition ... 723
Marine expositions ... 169
Marine insurance ... 87
Metric system, again ... 169
Motorships ... 334

Naval engineer, the ... 254
Naval policy ... 86
Naval policy ... 485
Naval program and economy ... 723
Naval program, our ... 412

Ocean liners and passenger ships ... 86
Operating cost per ton ... 722
Operation has helped carry construction... 723

Panama canal tolls ... 500, 797
Passenger ships and ocean liners ... 86
Passenger vessels ... 168
Pioneer purchasers ... 500
Port facilities ... 575
Prohibition on American passenger lines... 86

Protection for shipping ... 484
Protection or subsidies ... 721
Purchasers, pioneer ... 872

Reduced insurance ... 651

Sale of Shipping Board vessels ... 252
Schwab, English recognition of ... 650
Scrapping war vessels ... 871
Scythia, the steamship ... 795
Sea habit, the ... 254
Seamen's act ... 87
Seaman's act handicaps passenger ships on the Great Lakes ... 333
Seattle spirit ... 411
Shipbuilding returns, Lloyds ... 652
Shipbuilding sustains steel corporation ... 486
Shipbuilders' claims ... 333
Ship and sail on American vessels ... 486
Ships, America not over supplied with ... 253
Ships, buy now ... 499
Shipping and foreign trade ... 796
Shipping Board Appropriation ... 652
Shipping Board, the ... 169, 410
Shipping Board makes great mistake ... 575
Shipping Board vessels, sale of ... 252, 412
Shipping is the answer ... 484
Shipping policy ... 499
Shipping, protection for ... 484
Shipping, support American ... 576
Sinews of war ... 170
Standards, the ... 170
Standardizing joiner work ... 412
Status of naval engineers, the present ... 170
Steamboat inspection, proposed fees for ... 499
Steamship Scythia, the ... 795
Steamships, ocean liners and passenger ... 86
Subsidies or protection ... 721
Subsidy ... 252
Subsidy versus government ownership ... 168
Subventions, shipping ... 872
Superheated steam ... 576
Superheaters ... 485
Support American shipping ... 576

Tax on yachts and motorboats ... 651
Ter Meulen plan ... 411
Tolls, Panama canal ... 500, 797
Tonnage, obsolete ... 410
Trade policy needed, foreign ... 724
Trade routes ... 724
Transatlantic service, new ... 334
Turbine, the gas ... 485

Vessels for lighthouse service ... 576
Vessels for lighthouse service urgently needed ... 410

War vessels, scrapping ... 871

Yachts and motorboats, tax on ... 651

LAUNCHINGS

Blue Hen State, steamship ... 263
British Viscount, oil tank steamer ... 263
Britmex, Number 11, oil barge ... 179

Centennial State, passenger and cargo ship 97
Choluteca, fruit steamship ... 92
Conde de Churruca, twin screw motor vessel ... 647
Conte Rosso, passenger and cargo steamship ... 349

El Ghazi, steel motor-coasting vessel ... 349

Freighter, West Chopaka ... 866
Freighter West Prospect, 11,000-ton ... *717

G. Harrison Smith, combination ore and oil steamship ... *717
Gulfprince, oil tanker ... 418

Henry D. Whiton, steamship ... 263

Levant Arrow, tanker ... 717
Lone Star State, passenger and cargo steamship ... 97

Margoana, passenger and cargo motorship ... 180
Melines, railway steamer ... 261
Modasa, passenger steamship ... 167
Mont Viso, steel screw steamer ... 647
Motorship El Ghazi ... 349
Motorship, passenger and cargo, Margoana, 10,500 deadweight tons ... 180
Motorship, twin screw, Conde de Churruca, 4,500 gross tons ... 647
Mount Carroll, 3rd class passenger ship.. *262
Munargo, steamship ... *789

Nirpura, British steamship ... 99

Oil barge Britmex, Number 11 ... 179
Oil tank steamer British Viscount ... 263
Omaha, U. S. scout cruiser ... 95

P. L. M. 23, steamship ... 179
Peninsula State, steamship ... *699

Records broken, launching ... 97
Robert G. Hopkins, tanker ... 717

S-48 United States submarine ... *273
S-51, United States submarine ... *790
Saint Mary, steamship ... 263
San Leopoldo, oil burning tanker ... 643
Sierra Morena, cargo steamer ... 647
Solanas, steamship ... 263
Steamer, steel screw, Mont Viso, 7,800 deadweight tons ... 647
Steamship Blue Hen State, 21,900 gross tons ... 263
Steamship, cargo, Sierra Morena, 6,400 deadweight tons ... 647
Steamship, cargo, Vechtdyk, 6,500 deadweight tons ... 263
Steamship G. Harrison Smith, ore and oil ... *717
Steamship Henry D. Whiton, 7,000 deadweight tons ... 263
Steamship Melines, railway ... 261
Steamship Munargo ... *789
Steamship, oil burning, San Leopoldo ... 643
Steamship, oil tank, British Viscount, 10,000 tons ... 263
Steamship, oil tanker Gulfprince, 9,970 deadweight tons ... 418
Steamship, oil tanker, Sun Ubaldo, 8,400 deadweight tons ... 346
Steamship P. L. M. 23, Sir Raylton Dickson & Co., Ltd., 8,900 tons ... 179
Steamship, passenger and cargo, Conte Rosso, 18,000 gross tons ... 349
Steamship, passenger, Modasa, 10,750 deadweight tons ... 167
Steamship Peninsula State, 21,200-ton ... *699
Steamship Saint Mary ... 263
Steamship Solanas ... 263
Steamship, tanker, Levant Arrow, 18,277-ton ... 717
Steamship, tanker, Robert G. Hopkins, 10,000-ton ... 717
Steamship, 3rd class passenger, Mount Carroll, 10,500 deadweight tons ... *262
Steamship Tilthorn, 10,800 tons ... 647
Submarine S-48, United States ... *273
Submarine S-51 ... *790
Sun Ubaldo, oil tanker ... 346

Tilthorn, steamer ... 647

Vechtdyk, cargo steamer ... 263
Ville de Dannemarie, steamship ... 71

Washington, U. S. Battleship ... *752
West Chopaka, freighter ... 866
West Prospect, Shipping Board freighter ... *717

Ysseldyk, steamship ... 695

PARAGRAPHS

Administrative ruling ... 221
American Bureau of Shipping Bulletin ... 33
Atlantic Coast Shipbuilders' Association, report ... 82

Board of trade figures covering entrance and clearance of vessels at British docks 339
Bulletin, American Bureau of Shipping ... 33

Coal, export, classification of ... 305
Computers wanted ... 661
Corrections ... 167, 661

Dry dock, Philadelphia navy yard, test of ... 228

Editor to aid Hoover ... 489
Electrive drive in the navy ... 65
Electric lanterns for oil ships ... 730

George Washington to make Mediterranean cruise ... 825

Lanterns, electric, for oil ships ... 730
Lake plan of vessel salvage ... 140
Leviathan, reconditioning the ... 806

Management Engineering ... 595
Merchant marine convention: National merchant marine association ... 48
Merchant marine idle ... 221
Metals and alloys, informational service concerned with ... 114

Reconditioning the Leviathan ... 806
Royal Mail Steam Packet Company, new service begins ... 357

Salvage of vessel, Lake plan ... 140
Shipbuilding capacity of Germany ... 320
Shipbuilding in Australia ... 323
Shipbuilding returns, Bureau of Navigation 390
Shipping Board, last keel laid ... 380
Shipping Board to appoint director of operations ... 502
Shipyard, Italy plans new ... 390
Shipyards, Italian prosperity ... 153
Shipyards, new, for the Argentine ... 153
Steamship Mirzapore ... 359
Superheater Company, change of name ... 331

Tankers, French ... 171
Tonnage, British, lost during the war ... 230
Trade depression, best antidote for ... 243

Vessels delivered by Germany ... 314

PERSONALS

Andrews, John F ... 860

Bailey, John A ... 784
Bailey, John E ... 860
Baker, Frederick W ... 416
Blasdale, W. H ... 938
Barr, George W ... 783
Bean, Holly Marshall ... 938
Benson, Rear Admiral W. S ... *564
Bibbins, James Towland ... 467
Biles, Sir John Harvard ... 638
Bonnaffon, E. W ... 176
Brown, Harry ... 175
Brundage, D. Earle ... 712
Buchanan, G. L ... 260
Bull, William L ... 687

Campbell, R. S ... 94
Carman, Edwin S ... *175
Carson, D. B ... 176
Carson, David B ... *783
Chamberlain, George E ... *565
Christen, Albert ... 490
Clear, T. L ... 860
Collins, William H ... 711
Cooley, Mortimer E ... *938
Cornbrooks, Thomas M ... 564
Cox, Daniel H ... 938
Coxe, William G ... 564
Cropley, M. F ... 783
Crowley, D. J ... 176
Currier, David, Jr ... 340

Davis, J. M ... *565
De Lapotterie, Harry ... 93
Dearborn, Henry ... 490
Debus, P. A ... 564
Decker, W. E ... 784
Deering, Gardiner G ... 938
Delaney, A. Louis ... 93
Donald, John A ... 175
Dor, Leopold ... 859
Duffy, H. A ... 784
Durtnall, Captain William P ... *416

Ellison, Captain L. H ... *93
Emrich, M. F ... *341

Francis, R. L ... 784
Frey, A. J ... *639
Friese, E. L ... 938
Friezer, F. G ... 708
French, Lester Gray ... 416
Forbes, William Dunderdale ... 416

Gamon, Truman A ... 490
Geary, L. E ... 93
Germain, E. B ... *711
Gibbs, W. F ... 93
Graham, Thomas A ... 783
Gregg, E. S ... 783

Harding, H. McL ... 260
Harriman, W. A ... 490
Harter, Isaac ... 639
Henry, Sidney ... 860
Herreshoff, Nathaniel Green ... 416
Higgins, Howard C ... 176
Hill, E. B ... 175
Hogan, Robert L ... 93
Hunter, John ... 260
Hunter, John ... *340
Hyzer, Edward M ... 175

Isherwood, J. W ... *565

James, R. S ... 712
Jansson, A. Harold ... 490

Keene, W. B ... 712
Kennedy, William M ... 260
Kimball, Harry ... *859
King, Clarence Samuel ... 260
Kirby, Frank E ... 93

Lasker, Albert D ... *503
Laurent, A. G ... 712
Lee, Robert C ... 860
Levenhagen, R. W ... *176
Lissner, Meyer ... *564
Love, William J ... *639
Luscombe, Sir John ... 490
Lysholm, Henry ... *860

MacNeil, Paul H ... 340
McCarthy, William A ... 938
McChord, Hon. Charles C ... *711
McDougal, Harris ... 93
McDougall, Alexander ... 176
McInnes, John ... 176
McKibbin, F. G ... 860
McNoble, Capt. E. L ... 784
Mack, A. F ... 712
Magrill, Samuel ... 784
Malkin, Morris ... 784
Mallory, Charles K ... 938
Mallory, Clifford D ... 712
Maloney, Dennis A ... 784
Matthews, John B ... *175
Miller, H. B ... 176
Morrell, Robert W ... 565

Moss, C. C ... 93
Muir, John J ... 93
Mull, J. Harry ... 711

Nakase, S ... 712
Niblack, Albert P ... *175
Niven, David W ... *783

O'Connor, T. V ... *565
Oatley, H. B ... *341
Orde, E. L ... 566

Page, Charles R ... *859
Plummer, Edward C ... *564
Pohlman, A. ... 93
Powell, Joseph W ... 260, 711
Proctor, H. R ... 860

Quade, William A ... 711

Robison, Rear-Admiral John Keeler ... *859
Robinson, Joseph A ... 784
Robinson, R. H. M ... 416
Rossbottom, Thomas H ... *783
Ruck-Keene, Harry A ... 711
Ryder, G. E ... *341

Sarnoff, David ... *490
Saunders, A. E ... *93
Schlessinger, Elmer ... 565
Shreck, H. ... 938
Scott, G. Norman ... *340
Scrutton, J. Herbert ... 490
Semmes, Richard M ... 176
Sheedy, Joseph E ... *859
Shepherd, Edwin A ... 860
Simpson, George ... 784
Smith, George W ... 938
Smith, Wilson Porter ... 176
Smull, J. Barston ... *639
Soldevilla, Juan ... 490
Sollit, Ralph ... 711
Sterling, George W ... 784
Sutherland, J. P ... 784

Thompson, Frederick I ... *564
Thornton, Jr., Frank ... 176
Tomlinson, J. D ... 490
True, Charles H ... *341

Warden, D. T ... 93
Watkins, Robert M ... 860
Weaver, C. W ... 94
Wells, George H ... 711
Wilson, Robert B. M ... 490
Wood, B. Frank ... 176
Wood, Wilmer M ... 784
Woodward, Commander V. V ... 661

Young, D. C ... *490

QUESTIONS AND ANSWERS

Are deck fittings weakened by galvanizing? 857
Atomizers, oil fuel ... *258

Barge, hopper, metacentric height of ... 781
Barges, power for towing ... 857
Baumé scale ... 92

Calculations for strength of ships ... *414
Characteristics of curve of metacenters ... *638
Correction, Q. 1132 ... 858
Corrosion of dissimilar metals under water 173
Crane, jib, and crankshaft problem ... *488
Crankshaft and jib crane problem ... *488
Curves, design, for open motorboat ... 173

Engines, paddle wheel, lining up inclined ... *563
Engine performance from indicator cards ... *562
Engines, reciprocating, versus geared turbines ... 259
Estimating the painting of ships ... 562

Galvanizing, are deck fittings weakened by 857
Geared turbines versus reciprocating engines ... 259
Guys, stresses in stack ... *709

Horsepower of river steamer ... 336
Hulls, use of special steel in ships' ... 937

Indicator cards, engine performance from ... *562

Jib crane and crankshaft problem ... *488

Lining up inclined paddle wheel engines ... *563

Machinery design problem, propelling ... 781
Machinery space, tonnage deduction for ... 91
Marine engineer, problems for a ... 857
Metacenters, characteristics of curve of ... *638
Metacentric height of hopper barge ... 781

Oil burning vessels, number of ... 92
Oil fuel atomizers ... *258
Oil, transporting in wooden ships ... 488

Paddle wheel engines, lining up inclined ... *563
Packing pipe joints ... *563

Painting of ships, estimating..... 562
Painting of ships, estimate, correction.... 710
Pipe joints, packing..... *563
Plates, stealer *339
Power for towing barges..... 857
Problems for a marine engineer..... 857
Propellers, sectional, setting blades of on Lake steamers 258
Propellers, strength of..... 91
Propelling machinery design problem..... 781

Reciprocating engines versus geared turbines 259
Robertson's curves 937

Stack guys, stresses in..... *709
Speed of ship and revolutions of propeller 637
Stealer plates *339
Steels in ships' hulls, use of special..... 937
Strength of propellers..... 91
Strength of ships, calculations for..... *414
Stresses in rigging mast..... *258
Stresses in stack guys *709

Tonnage deduction for machinery space... 91
Towing barges, power for..... 857
Transporting oil in wooden ships..... 488
Turbines, geared, versus reciprocating engines 259

Use of special steels in ships' hulls..... 937
Wind resistance of vessel's topside and superstructure surfaces 637

Yacht design, underwater characteristics... 710

TECHNICAL PUBLICATIONS

Data Sheets, Ship..... 176
Design of Warships. Wm. Hovgaard..... 172

Elements of Map Projection with Applications to Map and Chart Construction. Charles H. Deetz..... 784
Extracts from Rules. American Bureau of Shipping 487

Handbook, Marine Engineers. Frank Ward Sterling 256

Inventions: Their Development and Sale. William E. Baff..... 90

Johnsons Steam Vessels, 1921..... 487

Marine Engineers Handbook. Lieut. Frank Ward Sterling 256
Marine Propellers. Sidney W. Barnaby... 257

Metallic Packing. Julian N. Walton.... 413
Modern History of Warships. William Hovgaard 89

Oil Fuel Burning in Marine Practice. J. W. M. Sothern..... 89

Packing for Export Shipment. C. C. Martin 335
Packing, Metallic. Julian N. Walton..... 413
Port of New York Annual. Smith's Port Publishing Co. 784
Powering of Ships, The. J. Bertram Thomas 858
Propellers, Marine. Sidney W. Barnaby.. 257

Recommended Practice for Electrical Installations on Shipboard..... 712

Ship Data Sheets..... 176
Ships, the Powering of. J. Bertram Thomas 858
Steam Boiler Engineering (Helios)..... 487
Sweet's Engineering Catalogue..... 566

Warships, Design of. Wm. Hovgaard..... 172
Warships, Modern History of. William Hovgaard 89

Marine Engineering

Volume XXVI JANUARY, 1921 Number 1

JAN 24 1921 U. S. PATENT OFFICE

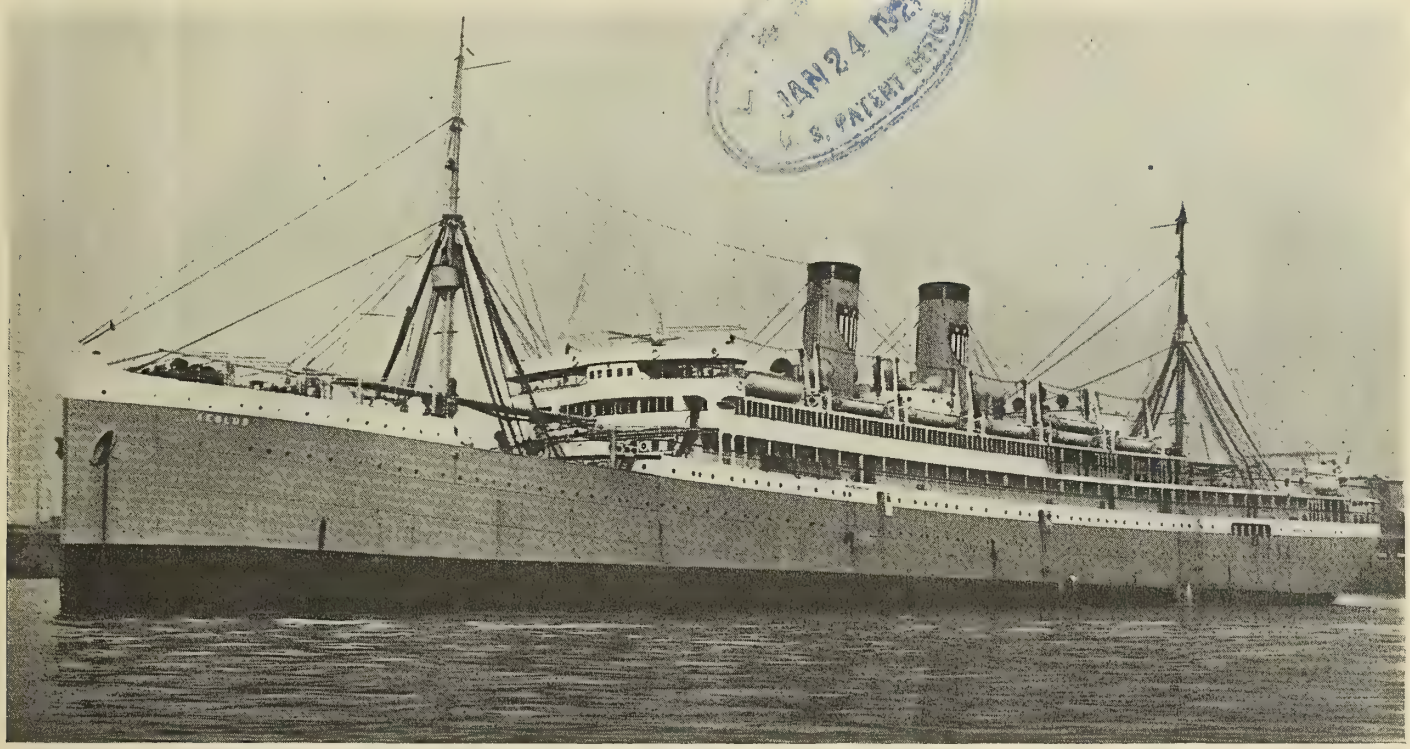


Fig. 1.—Munson Liner *Aeolus*

Steamship Aeolus Re-Conditioned

Former German Liner, Recently Used as War Transport, Remodelled for South American Passenger and Freight Service

BY H. G. CROSBY*

MARKING the completion by The Baltimore Dry Docks & Ship Building Company, Baltimore, Md., of one of the most extensive ship repair contracts ever awarded in the history of the United States, with an expenditure of nearly three million dollars involved, the steamship *Aeolus*, formerly the North German Lloyd liner *Grosser Kurfurst*, left Baltimore on November 20 on her way to New York, where she was delivered to the Munson Steamship Company for operation in their South American service. In outward appearance the vessel, with its battle-gray hull and white superstructure, presents a very pleasing picture, while an inspection of the various decks will disclose all the comforts and luxuries of the modern and up-to-date ocean liner.

In her entirety this vessel has been renovated; in addition to the remodeling of the quarters, an extensive refrigerating system has been installed which provides for the preservation of the various articles of food consumed during a voyage, as well as a cargo of frozen meats. Finally, in accordance with modern practice, the ship has been converted from a coal burner into an oil burner with a system of thirty-six furnaces operating under natural draft.

* Assistant general manager, Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md.

Built in 1899 at the yard of F. Schichau, Danzig, Germany, for the North German Lloyd Line, this vessel made her maiden voyage during the winter to Asiatic and Australian ports. The following spring her arrival at New York marked her first transatlantic trip, and from then until the outbreak of the great war in 1914 she plied between New York and Bremen.

At the outset of the war she was interned, with other German vessels then on this side of the Atlantic, and later was seized by the United States Government upon our entrance into the war. The vessel was then turned over to the Navy Department for operation, the name being changed to *Aeolus*. She was then fitted out as a transport and figured in this capacity until late in 1919.

Her war career included several exciting incidents, one being the occasion when she rammed the steamship *Huron*, ex-*Friedrich der Grosse*. Both vessels were in the same convoy and headed for France when, while pursuing a zig-zag course in the submarine zone, the *Aeolus*, due to mistaken signals, was forced by another vessel to bear over against the *Huron*. At the moment of striking, the bow of the *Aeolus* lifted on the crest of a wave and the resultant damage was that the *Huron* caught the blow above the waterline on the

starboard side, amidships, thus narrowly averting a serious catastrophe. Both vessels were forced to put back to New York for repairs but were soon in service again.

Early in 1920 the contract for re-conditioning the *Aeolus* was awarded to The Baltimore Dry Docks and Ship Building Company, and it is this contract which has just been carried to a successful conclusion.

Description of the Vessel

The *Aeolus* is a combined passenger and cargo vessel, carrying first, second and third class passengers. She is of the twin screw type, being driven by two quadruple expansion engines with a total of 9,000 indicated horsepower. The boilers comprise five double end and two single end units. The machinery is located amidships.

Fig. 2.—Children's Playroom

The following figures give an excellent idea of the size and capacity of the *Aeolus:*

Length overall	580 feet 10⅞ inches
Length between perpendiculars	561 feet 5/16 inch
Beam, molded	62 feet 4 1/16 inches
Depth, molded	39 feet 4 7/16 inches
Load draft	30 feet ½ inch
Displacement at load draft	22,450 tons
Gross tonnage	12,642.63 tons
Deadweight tonnage	11,205 tons
Net tonnage	6,992 tons
Speed, loaded	15.5 knots
Steaming radius	18,000 knots
Total capacity of fuel oil tanks	5,866 tons
Ballast and feed tanks	878 tons fresh water
Domestic tanks	1,483 tons fresh water
Cargo spaces	191,041 cubic feet
Refrigerated cargo spaces	58,244 cubic feet
Refrigerated space for ship's use	8,783 cubic feet
First class passengers	194
Second class passengers	70
Third class passengers	[illegible]
Officers	[illegible]
Crew	234
Total complement	718

General Arrangement

The *Aeolus* has a total of seven decks. There are two superstructure decks: "A," boat deck, and "B," upper promenade deck; "C," lower promenade deck, which is a long bridge and poop combined. Below the bridge deck are "D," upper deck; "E," main deck, and "F," lower deck, all of which extend fore and aft. Below "F" deck there is a "G," orlop deck, beyond the machinery space and extending to the ends of the vessel. Beneath this is the hold of the vessel.

A flying bridge on top of the pilot house and a docking bridge aft give a commanding view in navigating the ship.

A double bottom extends all fore and aft, subdivided for carrying fuel oil and water. The peak tanks are fitted for carrying water ballast. Below the main deck there are fifteen oil- or watertight bulkheads dividing the hold into the following compartments: In the forward part of the ship are the fore peak, Nos. 1, 2 and 3 cargo holds, and aft of these are the deep tanks for carrying fuel oil, with a centerline division. Number one and two boiler rooms follow in order, with oil settling tanks on each side and the pump room in between. Then comes the engine room. Aft of the engine room, and below "G" deck, is located the refrigerating machinery space with water tanks on each side. These water tanks extend to the after peak on each side, also between the shaft alleys. Between the main and orlop decks and aft of the engine space, three holds are insulated for carrying frozen meat, and, finally, a space for baggage is provided in the extreme after end of the vessel.

Fig. 3.—Skylight Over Music Room

A description of the accommodations provided for the three classes of passengers, the officers and crew shows them to contain everything necessary for the comfort and convenience for the lower classes, and in the case of the higher classes a luxury not surpassed by the most modern hotel. An inspection of the quarters invariably produces exclamations of admiration and the details of arrangement prove interesting reading.

Fig. 4.—First Class Music Room

Fig. 5.—First Class Smoking Room

Fig. 6.—First Class Lobby on "B" Deck

Fig. 7.—Second Class Social Hall on "C" Deck

Fig. 8.—Stairway and Dining Room Lobby

Fig. 9.—Stairway and First Class Lobby on "C" Deck

Accommodations for First Class Passengers

Accommodations for first class passengers are provided amidships on "B," "C" and "D" decks. The music room, which is located at the extreme forward end, is entered from a lobby with large doors opening to the enclosed promenade. In the center of this music room is a well looking down on the ladies' lounge and below that the main stairway to the dining saloon. Overhead is an art glass dome protected by a heavy steel skylight outside. Electric lights are provided about the dome for illumination at night. Numerous windows all around the sides provide ample light during the day. These windows are glazed with satin glass cut into small squares with a narrow edge of blue all around. Above the windows are silk panels in blue and gold. The seating arrangement is liberal, providing best straight back and comfortable arm chairs as well as numerous large settees. The furniture is all upholstered in blue plush, having a gold background. The floor is completely covered with a tan velvet carpet.

Situated at the after end of the space allotted to first class passengers on this deck is the smoking room, opening onto an open air veranda. Extending the full width of the house, this room is large, well lighted and ventilated, having large sliding windows all around. The side walls are paneled in oak, finished a silver gray. Two girders running the length of the room, as well as the drop beams, are encased in oak, finished to match the side walls. The floor is covered with cork tile, arranged in attractive design.

Heating of the above quarters is by means of steam, the floor type of radiators being used.

Between No. 1 and 2 boiler hatches is located a children's play room. In this room have been placed chairs and tables as well as a plentiful supply of toys of all descriptions. The side walls are painted cream color, with birds and animals in color for decoration. Light is by means of an art glass skylight.

Between the children's play room and the music room forward are three suites on each side, consisting of bed room, sitting room and private bath. Each bed room is equipped with two metal berths, one folding; chiffonier, built-in wardrobe, and two reed chairs. In the sitting rooms are one built-in berth, upholstered seat and back, writing desk and chair, one reed chair and built-in wardrobe. The baths have built-in tubs, water-closet and lavatory, tiled floor and side walls. The floors of the bed and sitting rooms are covered with carpet. The windows and doors are provided with curtains.

Between the children's play room and the smoking room aft are six staterooms with semi-private bath. Each stateroom is fitted with two metal berths, one folding; two reed chairs, one chiffonier, lavatory and built-in wardrobe. The floor is covered with carpet and curtains are provided for doors and windows. The bath has a lavatory, shower and water-closet, and the floor and side walls are tiled.

All rooms on this deck are outside, with doors opening onto an enclosed promenade.

On "C" deck two suites on each side open into the ladies' lounge. These suites are similar in every respect to those described on "B" deck, except that entrance is from the inside.

Seventeen staterooms occupy the remainder of this deck back to the second class accommodations. These are similar to those on "B" deck, except that entrance is by means of an inside passage.

Between No. 1 and 2 boiler hatches are public toilets and baths.

At the forward end of "C" deck, with the suites on either side as previously mentioned, is the ladies' lounge. In the center of this lounge is the main stairway leading to the dining saloon. Pilasters are applied to the side walls, which are painted light gray, plaster ornaments being used for decoration. The ceiling is paneled in small squares, painted white, with numerous ceiling domes. The floor is quartered oak, finished for dancing and covered with small rugs. As in the music room, the seating arrangement is generous, providing straight back and arm chairs and settees all upholstered in purple.

Just aft of the engine hatch is the library, with a passageway leading fore and aft to the first class rooms on this deck and a stairway leading up to the smoking room or down to the deck below. Here will be found the purser's office and also the doctor's office.

On "D" deck at the forward end of the space under the bridge deck is located the main dining saloon. Extending the full width of the ship, with large air ports on three sides and a large art glass dome overhead, this room is well supplied with light and air. The seating arrangement accommodates all of the first class passengers at one sitting with two, four, six and eight person tables. The floor covering is of blue and white cork tile. Pilasters are applied to the side walls, with flush ceiling. The saloon is painted in white and old ivory.

Immediately aft of the dining saloon and to the port side of the vessel is the galley, pantry and bakery. Installed in these departments are assortments of the most modern equipment for preparing meals, etc., for the first class passengers. The chief steward's office is adjoining.

The first class staterooms on this deck all have private baths. Each stateroom has two metal beds, one folding; two chifforobes, two reed chairs and one dressing table with bench. The ports and doors are provided with curtains and the floors are covered with carpet. The bath rooms contain a water-closet, shower and lavatory, the floor and side walls being tiled.

Accommodations for Second Class Passengers

Second class passengers occupy the after end of "C," "D" and "E" decks. Each stateroom contains two metal berths, cushion settee, double wardrobe (built-in) and lavatory. The floors are all covered with a deck composition. Public baths are furnished on each deck.

The smoking room and social hall are at the after end of "C" deck. The smoking room is in the form of a semi-circle, with upholstered settees around the sides. The social hall extends the full width of the house, with large windows on each side and art glass skylight overhead.

The dining saloon on "D" deck is fitted out with long tables and straight back chairs with cushion seats, sufficient to seat all second class passengers at one time. Lighting is by means of air ports on each side.

The galley, which is just forward of the dining saloon, and which is smaller than the first class galley, is completely equipped.

Accommodations for Third Class Passengers

All third class passengers are quartered at the extreme forward end of "E" deck, with their galley and mess room on the deck above. The rooms are all fitted to accommodate four persons each, having metal berths with comfortable wire springs and fibre mattresses. Pine benches and metal lockers are fitted. The floors are covered with a deck composition.

Accommodations for Officers and Crew

Except for the officers' quarters on the boat deck the entire crew is taken care of on "E" deck. The engine room crew is grouped about the engine hatch, with storeroom, toilets and mess room all carefully fitted out for the comfort and convenience of the men.

The steward's department is located amidships with two-, four- and six-person rooms for all except the waiters, who are taken care of in two large rooms. The rooms are equipped with metal berths and lockers and wood benches. The floors are all covered with a deck composition.

The miscellaneous units of the ship's equipment, as described below, all tend to make the *Aeolus* complete in every detail. Safe navigation is made certain; heating, ventilation, methods of communication and other necessary installations have been taken care of, and, finally, every means of providing for the safety of passengers and crew at sea has been adopted.

Operating Equipment

Navigation.—On the navigating bridge, or in the pilot house, are located all the instruments necessary for the safe and efficient handling of a vessel of this size. Within view and easy reach of the officers in charge are the compasses, one magnetic and one gyro; docking and engine telegraphs; engine and revolution indicators; submarine telephones; pneumercators, which indicate the draft and displacement; speaking tube; telephone and call bells to all parts of the vessel, and control cabinets for the fire extinguishing system.

Pneumercators.—A complete pneumercator system has been installed for registering, at gages located in the pump room, the depth and capacity of fuel oil in each tank. Another pneumercator system, with gages in the pilot house, has been installed for registering the draft, trim, displacement and deadweight of the vessel.

Steering Gear.—For operating the rudder, a steam tiller is provided, located in the poop at the after end of "E" deck. The engine is steam driven, with double inverted cylinders and is controlled by a telemotor gear from the pilot house as well as from a station on the after end of "B" deck.

Wireless Telegraph.—Situated on the boat deck, between the two smokestacks, is a steel house in which are quartered the three wireless operators and four cadet officers. This house also contains the battery room and operating room for the wireless telegraph. An auxiliary generator, gasoline driven, used in connection with the wireless outfit, is located in the upper engine room casing just below the skylight.

Heating and Ventilating.—A complete ventilating system has been installed on "D" and "E" decks, including all assembly rooms, quarters, cabins, mess halls, toilet rooms, etc. The mechanical equipment consists of seven supply and six exhaust Sturtevant blower sets, each set having a fan driven by an electric motor. The supply sets are also equipped with tempering coils for tempering the air. The distribution of air is accomplished through sheet metal conduits leading to and from the fans to the various localities. All outlets are fitted with plain lattice pattern grills and registers.

Fire Extinguishing System.—All fuel oil tanks, except the double bottom tanks, have been equipped with steam smothering pipes leading to a common control manifold on "E" deck. For the cargo holds, including the refrigerated spaces, the "Rich" system for detecting and extinguishing fire has been installed, with detecting cabinets located in the wheel house and two control cabinets with steam smothering manifold on "E" deck.

For detecting fire in the passenger quarters, there is provided a patented device with indicators in the pilot house.

Life-Saving Equipment.—To care for the persons on board in case of accident, there are two 20-foot lifeboats and one 30-foot lifeboat of the open type, one 26-foot open motorboat and twelve 26-foot lifeboats of the decked type, with collapsible sides. All of these boats are placed under patented davits. The lifeboat capacity is sufficient to care for all on board.

Cargo Handling Gear.—Cargo gear for handling cargo to the six hatches consists of two masts and two derrick posts, each mast being fitted with eight wood booms operated by four steam winches, and each derrick post fitted with one wood boom operated by one steam winch. The ten winches are double cylinder, single drum, with extended heads.

Anchor and warping gear for handling the anchors consists of a large double cylinder geared windlass, mounted on the forecastle deck.

For handling the heavy lines with which this vessel is equipped there are four steam driven capstans. Two capstans are located on the forecastle deck and two on the after end of "C" deck. Bitts, chocks and roller fair leads are generous in number and of heavy construction.

On the boat deck are two steam winches with fair leads to each davit for hoisting the lifeboats.

Generating Plant.—The old electric generating plant, consisting of three German 35-kilowatt generators, driven by reciprocating steam engines and one 35-kilowatt General Electric turbo-generator, have been overhauled and re-arranged. A new 100-kilowatt General Electric turbo-generator has also been added.

Machine Shop.—On the port side of No. 2 boiler hatch, on "E" deck, is a completely equipped machine shop.

Laundry.—On the starboard side of No. 2 boiler hatch, on "E" deck, is provided a laundry of ample size to care for the needs of the entire vessel.

Propelling Machinery

The machinery of the *Aeolus,* hereinbefore mentioned, consists of the following:

The two quadruple expansion marine engines, with a total of 9,000 indicated horsepower, and driving two 17-foot 9-inch diameter propellers, have been thoroughly overhauled and put in first class condition.

Five double end boilers, 14 feet 2 inches diameter and 20 feet long, and two single end boilers, 14 feet 2 inches diameter and 10 feet 3 inches long, each built for a pressure of 220 pounds, have been converted from coal to oil burning.

The fuel oil burning equipment is of the mechanical atomizing type, two sets being furnished, each being capable of supplying the whole boiler plant, and each set consisting of the following:

Two 7½-inch by 4½-inch by 10-inch horizontal duplex oil service pumps.
Three oil heaters.
One suction strainer.
One discharge strainer.
One oil meter.
One regulating valve.
One steam trap.
Three thermometers.
Two pressure gages.

Both fuel oil sets, as well as a 10-inch by 10-inch by 12-inch horizontal duplex fuel oil transfer pump and all fuel oil manifolds, are located in the pump room, which is entirely watertight. This condition contributes greatly to the safety of the vessel, as with this arrangement either boiler room may be flooded while the other may still be served from the pump room.

Two old feed pumps, the grease extractor and feed heater have been removed and replaced by two 18½-inch by 13½-inch by 24-inch vertical simplex feed pumps of Worthington make; one Row & Davis feed water filter and grease extractor and one Row & Davis No. 36 Paracoil 2-pass feed water heater. A 10-inch by 20-inch by 16-inch vertical simplex featherweight auxiliary air pump, Worthington make, has been installed and oil fire pump has been replaced by a 12-inch by 14-inch by 12-inch vertical duplex Worthington pump.

The evaporating and distilling plant has been entirely renewed, the new installation consisting of:

Two 40-ton Row & Davis evaporators.
One 40-ton Row & Davis distiller.
One No. 30 Row & Davis aerating filter.

Refrigerating Plant

The refrigerating equipment on the *Aeolus* was designed, manufactured and installed by the Frick Company, Waynesboro, Pa. It consists of two carbon dioxide machines of the straight line tandem type wherein the compressor is placed

Fig. 10.—Enclosed Promenade on "B" Deck

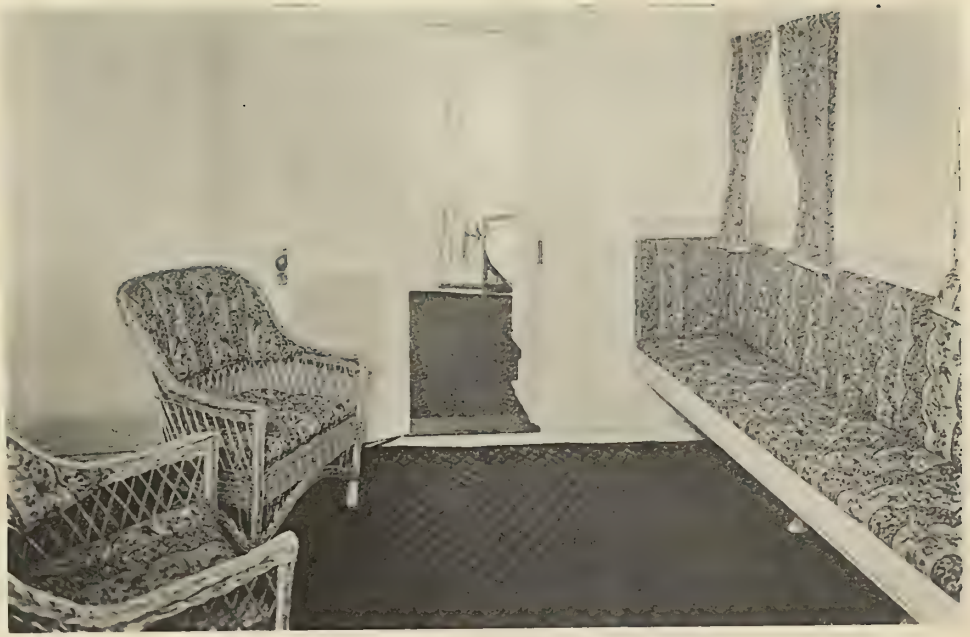


Fig. 11.—En Suite Rooms on "C" Deck

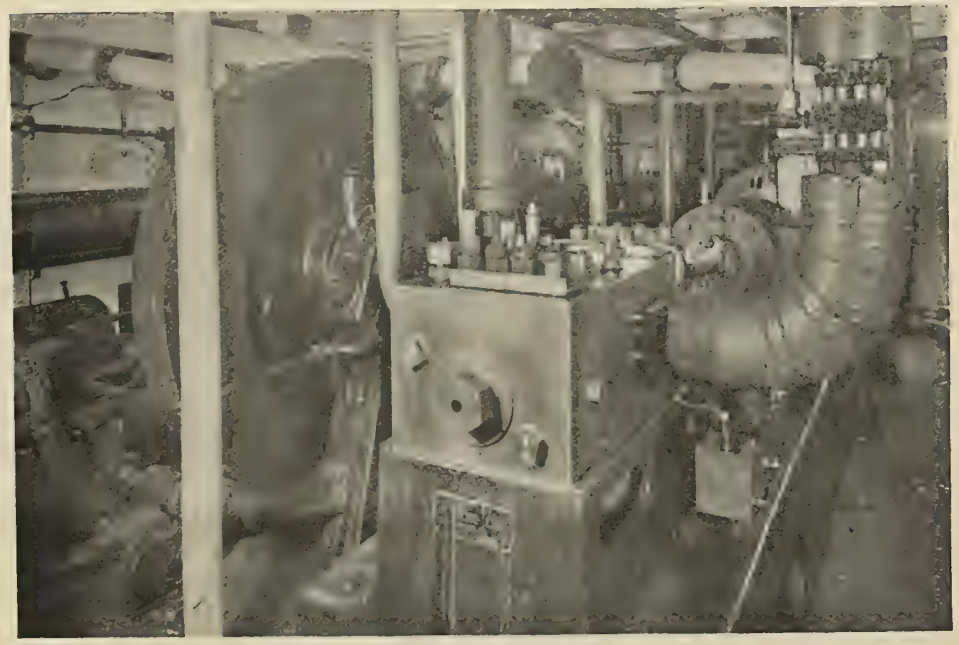


Fig. 12.—Refrigerating Machinery Space

Fig. 13.—Bed Room on "C" Deck

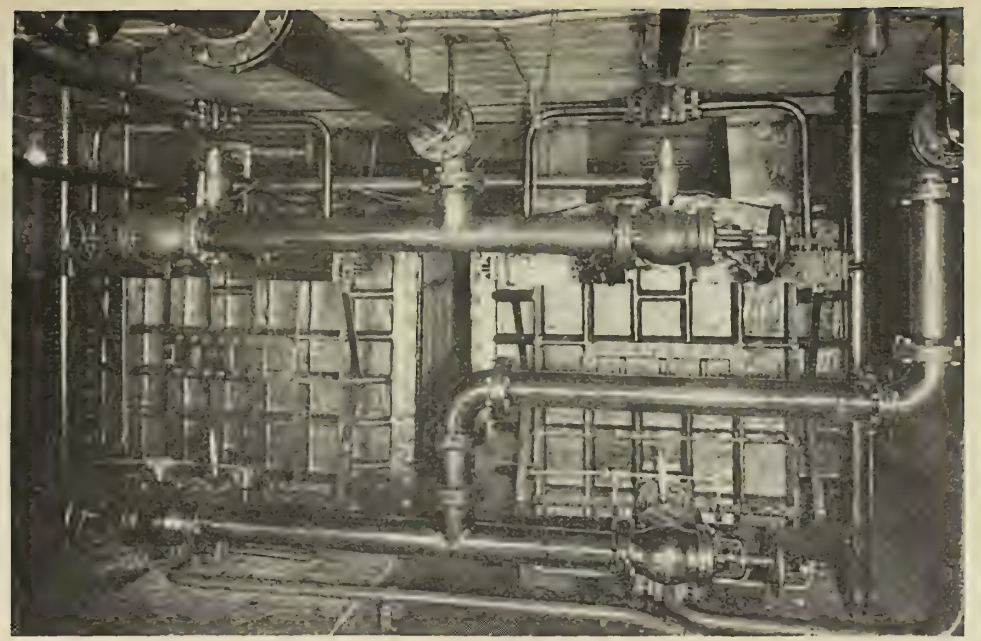


Fig. 14.—CO_2 Condensers

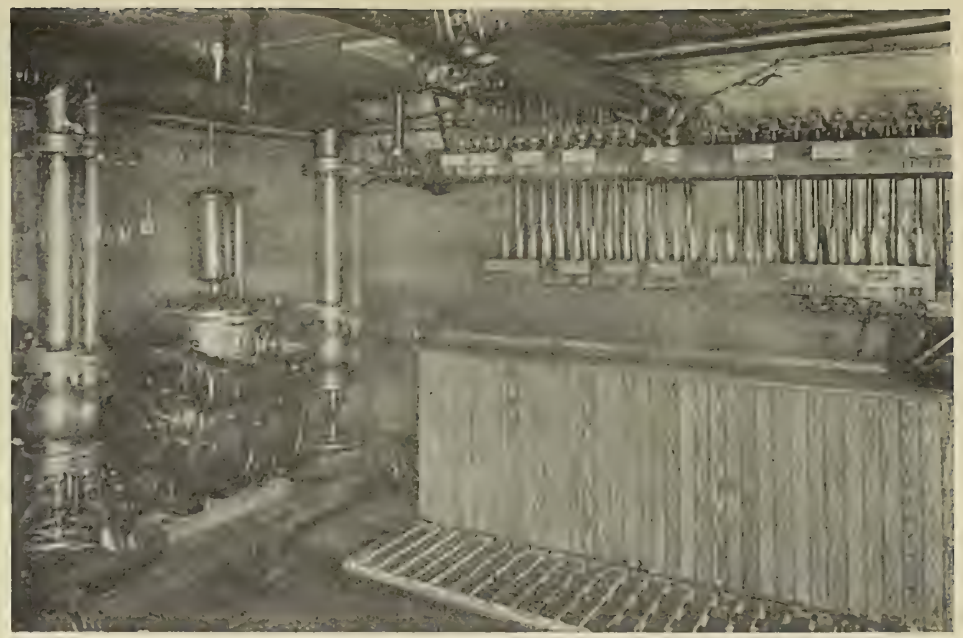


Fig. 15.—Brine Pump and Tanks

Fig. 16.—Refrigerated Cargo Space on "F" Deck

Fig. 17.—Fruit Room

behind and in tandem to the steam cylinders of a tandem compound steam engine. The carbon dioxide cylinders are 6½ inches bore by 18 inches stroke and the steam cylinders are 13 inches and 24 inches in diameter respectively for the high pressure and low pressure and 18 inches stroke. Each of these machines has a rated capacity of 80 tons refrigeration at 80 revolutions per minute, and together with the condensers and evaporators each has ample capacity to take care of the six cargo holds, small refrigerator boxes in first and second class galleys, first class bar, an ice making tank and an ice water circulating system. Actual cooling in the refrigerated spaces is done by the cold brine circulating method, the brine being cooled by the expansion of the carbon dioxide gas in the evaporators.

The refrigerated cargo holds are located at Nos. 4, 5 and 6 hatches between "E," "F" and "G" decks and are designated as F-4, G-4, F-5, G-5, F-6 and G-6. Their total capacity is approximately 102,000 cubic feet and they are piped with 1¼-inch brine pipe at a ratio of 4 cubic feet of space per lineal foot of pipe, making a total of approximately 26,000 cubic feet of pipe.

Carbon Dioxide Compressors

The two carbon dioxide compressors are located in a room under hold G-4 just aft of the dynamo room. G-4 is divided in half by an athwartship insulated partition. The after half into which No. 4 hatch opens is devoted to refrigerated cargo and the forward half is used as condenser and evaporator room. This forward half is further divided by a fore and aft insulated partition, thus making two rooms. The two condensers and condensing water pumps are located in the starboard room and the two evaporators, brine pumps, the brine return tank and the brine feed header are located in the port side room. Entrance to the compressor room is had by means of a small hatchway in the floor of the condenser room with a stair leading down.

The crank shafts of the carbon dioxide compressors are of the double bearing single throw type with fly wheel mounted between the bearings. The compressor cylinders are made from a solid block of nickel steel bored true and ground smooth through the working barrel and are fitted with nickel steel suction and discharge valves working in nickel steel cages. High and low pressure steam gages, vacuum gage and brine pressure gage are located in the engine room within easy view of the engineer and a carbon dioxide high pressure alarm gage was provided which sounds an electric alarm in case of an abnormally high pressure. Steam at 150 pounds pressure is used, being taken through a reducing valve from one of the ship's steam lines carrying boiler pressure at 200 pounds pressure and exhaust line is connected to one of the ships condensers, the steam engines thus operating condensing.

Condensers

There are two carbon dioxide condensers of the shell and coil type with removable heads, each containing 5,032 feet of ¾-inch extra heavy copper pipe made up in twelve separate coils. Two duplex steam driven water pumps, size 7 inches by 7½ inches by 10 inches, each having a capacity of 300 gallons per minute, furnish water for these condensers. Sea water is used for condensing and it is taken from a suction line through the ship's side and discharged overboard after passing through the shells.

In the condenser room there is a set of high and low pressure carbon dioxide gages for each compressor and the necessary carbon dioxide charging apparatus consisting of another gage, scale and heating tank, etc. All steam and water lines are made of copper pipe and thermometers are provided where necessary to aid the operators in securing proper operation.

The evaporators are of similar construction to the condensers and consist of two shells, containing extra heavy iron pipe, however, in place of copper pipe. Each shell contains 6,988 feet of 1-inch extra heavy pipe made up in twelve coils. There are two brine pumps, size 7½ inches by 10¼ inches by 10 inches, duplex steam driven, each having a capacity of 300 gallons per minute. The bases of these brine pumps are provided with extension pieces and the pumps are located so that the steam cylinders are in the condenser room and the brine cylinders in the evaporator room and the insulated partition is built around the beds of these pumps. This does away with the cumbersome insulation over the steam cylinders of the pumps which is necessary when the pumps are placed in the cold room.

Brine Mains

Warm brine leading from the various refrigerated holds, ice tank and boxes comes into the evaporator room through 1-inch mains and pours into a return tank. The brine pumps take it from this tank and force it through the evaporators, where it is cooled again and it then passes to the feed headers. From this header 1-inch feed mains carry brine to all parts of the ship where refrigeration is required. Every feed and return main has a control valve, and designating boards are provided on the feed header and return tank showing exactly what each valve controls. Thermometers are provided on each return main and the return tank, as well as on the inlet and outlet of the evaporators.

There is a brine heater to warm the brine when defrosting the coils in the refrigerated spaces. It is made of cast iron shell with a special steam coil inside and so connected that it can be cut in and out at any time desired.

Temperatures of Refrigerated Spaces

A temperature of 15 degrees F. is maintained in cargo holds F-6, G-6, F-5, G-5 and G-4, these being designed for carrying frozen beef. Hold F-4 is subdivided into four rooms for carrying ship's stores, such as meats, eggs, butter, cheese, vegetables, etc., and temperatures are maintained in these rooms to suit the nature of the contents. Thermometer tubes lead from the refrigerated holds up to "B" deck with two thermometers in each hold hung on brass chains fastened to deck blocks. This makes it possible to take temperatures in the holds by opening the deck blocks and pulling up the thermometers.

The 1¼-inch brine piping in the holds is arranged in ceiling and wall coils connected in circuits averaging 1,200 lineal feet each and fed from the brine header in the evaporator room. Removable hatch coils are provided with special four-way brine cocks on each coil, so constructed that a coil can be cut off and removed without losing any brine. Watertight ferrules are provided where feed and return mains pass through decks and bulkheads on way to evaporator room.

There is a scuttle butt for cooling drinking water. It consists of a round galvanized tank with spiral brine coils inside and the water is continuously circulated to drinking fountains in all parts of the ship by means of a 1-inch centrifugal motor driven pump. There is also a duplicate pump which is used as a reserve.

The ice making equipment has a capacity of one-half ton per day and is used for making ice for table use, etc.

There is a three-compartment refrigerator installed in the first class galley, two-compartment box in the second class galley, and a small box in the first class bar. These boxes are piped with 1-inch brine coils and also fed from the main header in the evaporator room.

Insulation

All refrigerated spaces are insulated with compressed corkboard insulation. In the holds F-4, F-5 and F-6, 2-inch by 3-inch wood grounds were bolted to the ship's frames on ceiling and walls with a layer of ⅞-inch tongued and grooved sheathing nailed to this followed by layer of 3-inch and then a layer of 2-inch corkboard. This was then finished by a

layer of 1⅛-inch tongued and grooved spruce sheathing. Waterproof paper was placed between each layer of sheathing in coils and between the courses of 2-inch and 3-inch corkboard. The spruce sheathing was finished with two coats of shellac.

An insulated ribbon was built around the ship's sides and exterior bulkheads on "F" deck extending 3 feet from the ship's side.

The insulation of G-4, G-5 and G-6 is similar to the "F" deck, with the exception of the floors, where 6 inches of corkboard with two layers of 3 inches each was laid in hot pitch and a finished spruce flooring was nailed to ground imbedded in the coils. A 3-inch hardwood floor was built under the hatches extending out 1 foot each way beyond the edge of the hatch in order to secure protection to the insulation when loading cargo. Heavy beveled yellow pine timbers were bolted to the hatch coamings and strong backs and removable insulated plugs fitted in them so that when cargo is loaded the holds can be completely sealed up.

Proper tests were run on the refrigerating equipment consisting of an 18-hour run while the ship was at anchor and a 12-hour operation during the sea trial of the ship when it was taken to New York. On reaching New York another 24-hour trial was run. In all the tests highly satisfactory results were secured. The desired temperatures were easily obtained in all the refrigerated spaces and the operation of all the refrigerating equipment was found to be all that could be desired.

Taken all in all, the *Aeolus,* completely equipped in every detail, should, under the operation of the Munson Steamship Company, to which she has been allotted by the United States Shipping Board, prove popular with tourists and travelers and serve to cement our friendly relations with the South American countries. As she now stands, the *Aeolus* in her reconditioned state is a credit not only to the Baltimore Dry Docks & Ship Building Company and to her operators, the Munson Steamship Line, but also to the merchant marine of the United States.

Steam Engine Driven Exciter Sets

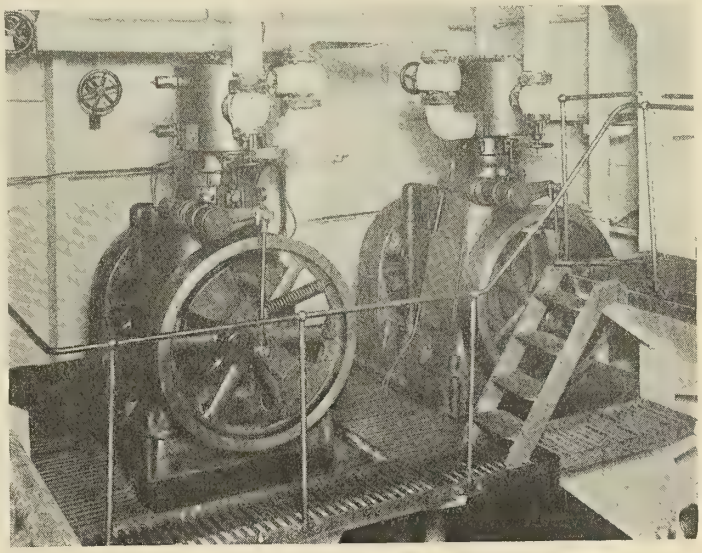
THE recent application of alternating current propulsion equipment to the *Eclipse,* the first of twelve ships to be similarly equipped by the United States Shipping Board, has called attention to another use for the small direct current steam engine driven generating set aboard ship.

Hitherto the marine application of these sets has been more or less confined to lighting purposes, but on these vessels they have been applied to supply energy for several different purposes. Two 35-kilowatt sets of this type have been installed on the *Eclipse* to furnish field excitation current to the alternator, besides which they furnish 125-volt, direct current power to operate contactors on the control board and to run the blower motor.

Generating sets similar in design to these, and ranging in capacity from 2½ kilowatts to 60 kilowatts, are made by the General Electric Company, primarily for marine purposes. They are, however, equally adaptable to various uses on land, such as supplying light and power in isolated plants and shipyards and as exciters for alternating current generators in central stations.

The complete set consists of a single cylinder steam engine directly connected to a direct current generator. The cylinder and stroke of the engines vary from 3½ inches diameter by 3 inches stroke for the 2½-kilowatt size to 12 inches by 11 inches for the 60-kilowatt size. Only one valve is used, and a short stroke has been adopted. The cylinders are separate from the column casting. Since the ports are short and direct, small clearance space is allowed. Automatic relief valves, to relieve water under ordinary operating conditions, and separate hand operated drain valves are fitted to each end of the cylinder. The steam distribution is accomplished through a single balanced piston valve, driven either by an eccentric strap or by a pin from the governor weight.

Governing is accomplished by two methods, depending upon the size of the engine. The 3½-inch by 3-inch, 4½-inch by 4-inch, 11-inch by 8-inch, and 12-inch by 11-inch cylinder engines are equipped with a flywheel type automatic governor, while the other sizes, from 5-inch by 4½-inch to 9-inch by 7-inch, have an enclosed type which is inside the column. In the latter type the piston valve is connected to



Exciter Sets on the *Eclipse*

the governor by an eccentric strap. The length of the valve stroke depends upon the distance of the center of the eccentric from the center of the shaft, and therefore the amount of steam admitted to the cylinder varies directly as the distance between centers. That is to say, the shorter the valve stroke the smaller the amount of steam admitted. If the speed reaches a dangerous point, the throwing out of the governor makes the valve stroke so short that no steam is admitted to the cylinder.

Lubricating System

The lubricating system also differs with the capacity of the engine. Those in the range from 2½ to 5 kilowatts employ a gravity system, the oil being contained in a conveniently located tank and supplied to the various bearings by a number of sight feed tubes. The other sizes are equipped with a forced lubrication system, which functions as follows: The bottom of the column, or crank case, forms an oil tank of large capacity and radiating surface. A small single acting plunger pump driven by an eccentric which is bolted to the crank shaft forces the oil, under pressure, to the various bearings of the engine. From the bearings the oil escapes and is collected again in the bottom of the crank case, where it cools, and is used over again.

The engines can be operated on pressures up to 125-pound gage, either condensing or non-condensing. When the pressure is above 125 pounds a reducing valve should be used. These engines will operate successfully on moderately superheated steam as used aboard ship.

All parts which would be seriously damaged by corrosion due to the action of salt air are either made of corrosion resisting material or given a protective treatment. The generators are regularly wound for either 110, 125 or intermediate voltages, and the series windings on the field spools will allow of over compounding up to 5 percent of normal, by means of a German silver shunt connected across the field terminals.

New Design of 10,000-Ton Tanker

Tankers Built on New Transverse System of Framing Designed by Chief Surveyor of British Corporation

THE accompanying plans illustrate a new type of tank steamer, several of which are at present being constructed by Sir W. G. Armstrong Whitworth & Company, Limited, at their Armstrong yard, Newcastle-on-Tyne, England. This firm, which has had a long and varied experience in the construction of tankers, having built more vessels of this type than any other firm, has been entrusted by British Tanker Company, Limited, with the construction of several vessels of this new type. The efficiency and reliability of the service of the previous tank steamers built by this firm is an augury of the success of these vessels.

Each of these vessels is built for the carriage of oil in bulk and a special feature of the design is that cargoes ranging in density from 35 to 51 cubic feet per ton can be carried without leaving any of the main compartments empty, thereby avoiding a condition productive of severe straining actions upon the structure. This desirable arrangement has been obtained without increasing the free surface beyond that usually found in tank steamers of this size.

Principal Dimensions

The principal dimensions of the vessels are as follows:

Length overall	455 feet 1 inch
Length between perpendiculars	440 feet 0 inches
Breadth, extreme	57 feet 6 inches
Breadth, molded	57 feet 2 inches
Depth, molded to upper deck	33 feet 11 inches
Mean loaded draft	26 feet 3 inches
Deadweight	10,100 tons

General Arrangement

Each vessel is of the two deck type with poop, bridge and forecastle, the poop being of sufficient length to cover the engine and boiler space.

The oil forming the cargo is carried in nine double tanks divided into three groups by two pump rooms. Stowage for oil fuel is provided in two cross bunkers, one forward and one aft, and when it is desired to undertake voyages of exceptional length additional oil fuel can be carried in the forward deep tank. A cofferdam is worked at each end of the cargo tanks and cross bunkers, and between these limits the main deck is parallel to the base line, the height of 'tween decks being determined by the capacity required for the oil of greatest density provided for.

The total capacity of the main holds with their expansion trunks is sufficient for a full cargo of petroleum, but the tanks at the sides of the trunks must be utilized when carrying spirit. Each main tank and each side tank is fitted with a separate hatchway, those to the side compartments having deep coamings to serve as expansion trunks.

In addition to the stowage arranged for oil fuel, coal bunkers are fitted in the 'tween decks directly over the boilers with chutes leading to the stokehold.

Water ballast can be carried in the fore peak, after peak, fore deep tank and double bottom tank under the engines. Boiler feed make up water is carried in the double bottom under the boilers.

The space forward between the upper deck and the top of the deep tank is fitted as a cargo hold.

Ample storeroom space is provided throughout the vessel.

The vessel has two masts, each carrying two derricks, one on the fore side and one on the after side, and two steam winches for working these derricks. A large warping winch is also fitted on the poop deck aft.

In addition to the usual bollards, a large towing bollard is fitted at the after end of the vessel, with a bridle arrangement to the wing bollards, so that derelicts may be taken in tow.

Accommodations

The accommodations, which are more elaborate and extensive than is usual in vessels of this type, are arranged as follows:

Seamen and firemen in the forecastle and on the upper deck forward, the men being berthed not more than two in one room. The mess rooms are commodious and every attention has been paid to the sanitary and washing arrangements.

Officers are accommodated on the bridge deck, upper bridge and flying bridge in large and airy rooms, their comfort having been specially considered.

The engineers' quarters are situated in the poop aft of the engine casing, the style and fittings being similar to that of the officers.

Petty officers' quarters are also arranged in the poop, at the sides of the engine casing, as are their mess room, entrances, etc.

Storerooms, hospital, etc., are placed in the bridge with doors opening directly to the deck.

The galley is fitted in the engine and boiler casing and equipped with all necessary cooking appliances.

Refrigerating machinery and cold chambers are arranged on the second deck aft of the engine room, the machine being placed in such a position as to be constantly under the supervision of the engineer.

Hull

One of the unique features of the vessel is the structural framing which is being carried out on the Foster King transverse system. For many years the transverse system of construction in oil tankers has suffered as compared with the Isherwood longitudinal system on account of the greater weight of structure in the former as compared to the latter. J. Foster King, of the British Corporation, has patented a system of transverse framing in which the total weight will certainly not exceed that of the longitudinally framed vessel.

In this system a number of deep longitudinal girders are fitted to the bottom and sides of the vessel and also to the center bulkhead. At the transverse bulkheads these girders are carried athwartships, while one or more deep floors are arranged in each oil compartment according to its length. The deep girders on the transverse and fore and aft bulkheads are so arranged that alternate tanks are left clear for calking.

The transverse framing has been reduced, and, as already stated, a considerable saving in the structural weight has resulted compared with the old transverse framed tanker. In addition, the erection has been simplified and the riveting reduced to a minimum.

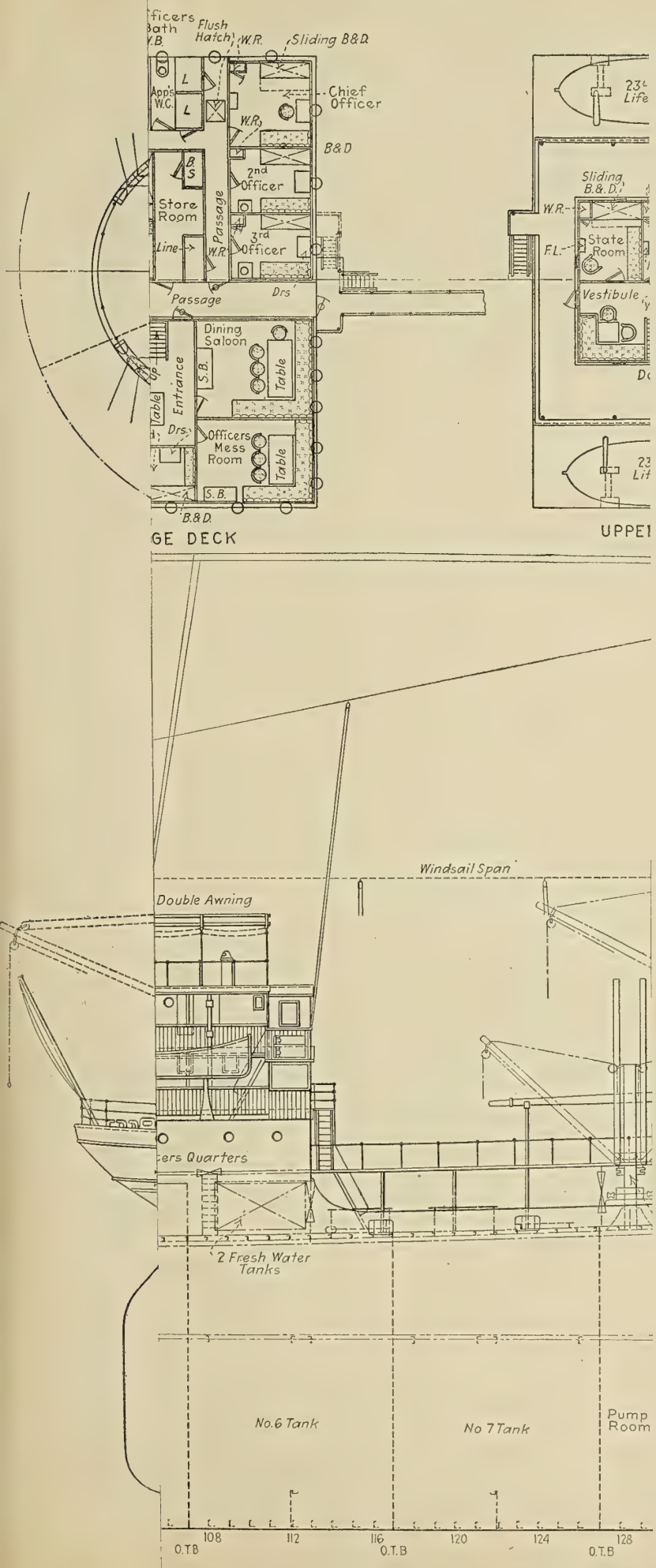
Main Propelling Machinery

The vessel is propelled by a single set of triple expansion engines of 3,000 indicated horsepower having cylinders 27 inches, 46 inches and 77 inches diameter by 51 inches stroke. A complete set of auxiliary machinery is being installed.

Boilers

Steam is generated in four watertube boilers of the Babcock and Wilcox type working at a pressure of 200 pounds per square inch with a closed duct forced draft arrangement, the

N TANKER



Upper Deck, Molded, 33 Feet 11 Inches; Deadweight Carrying

NEW DESIGN OF 10,000-TON TANKER

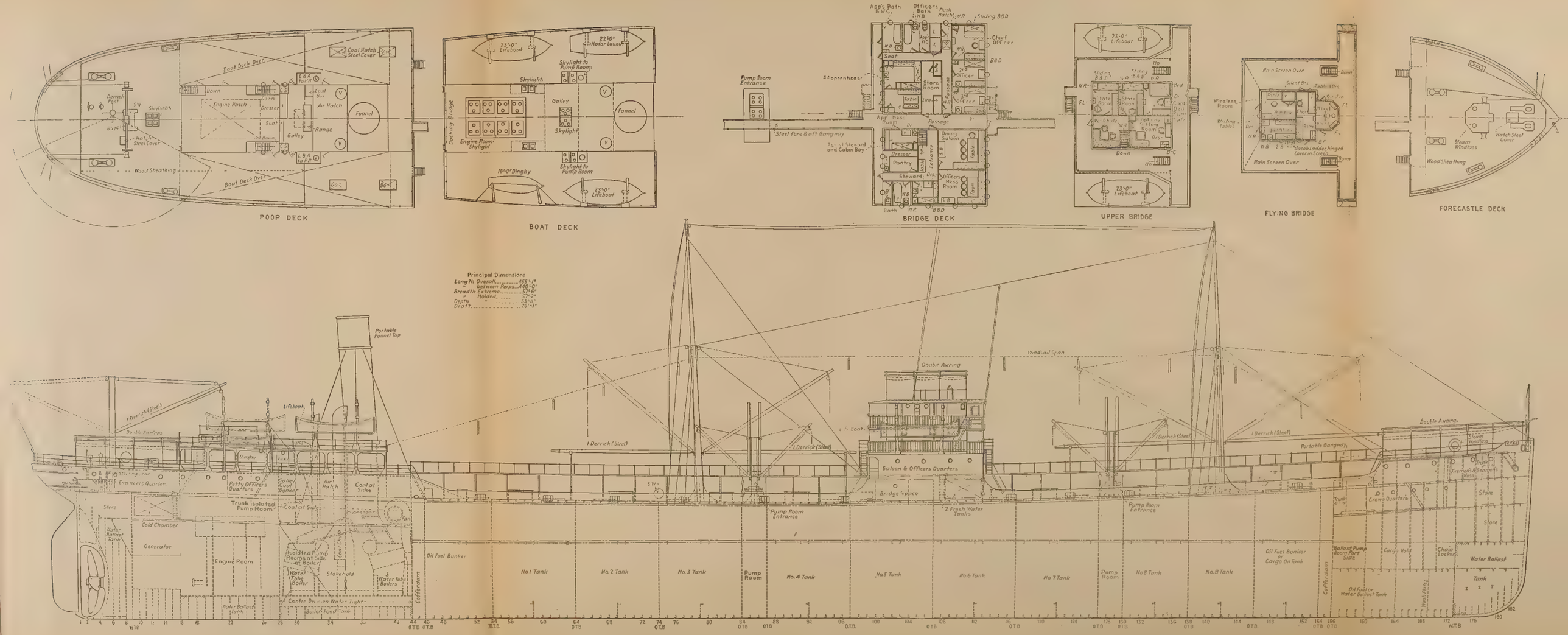
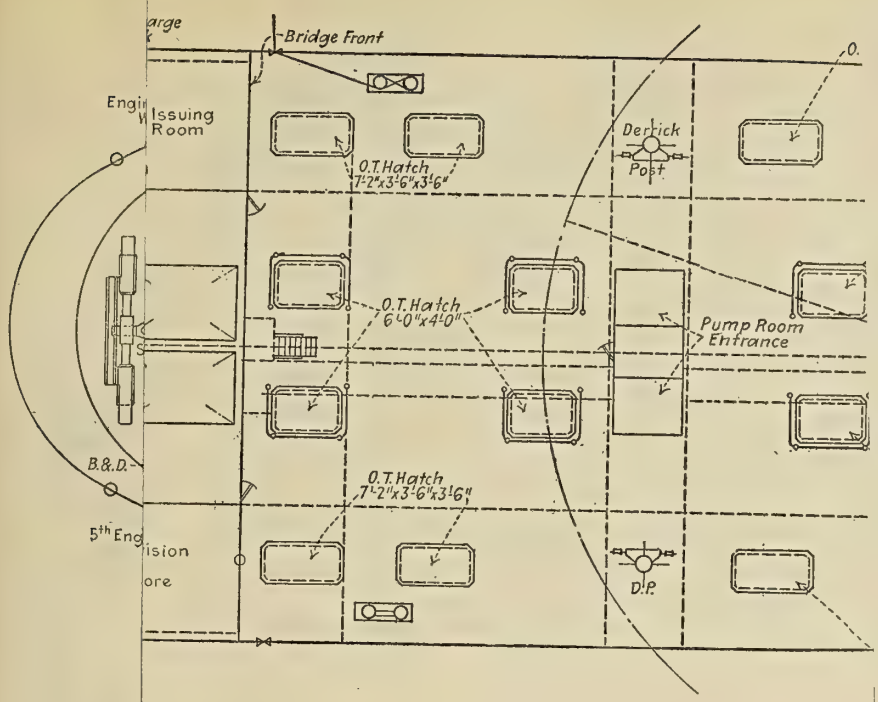
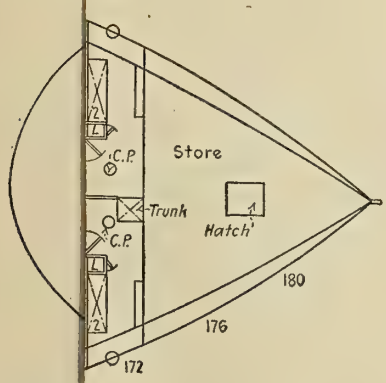
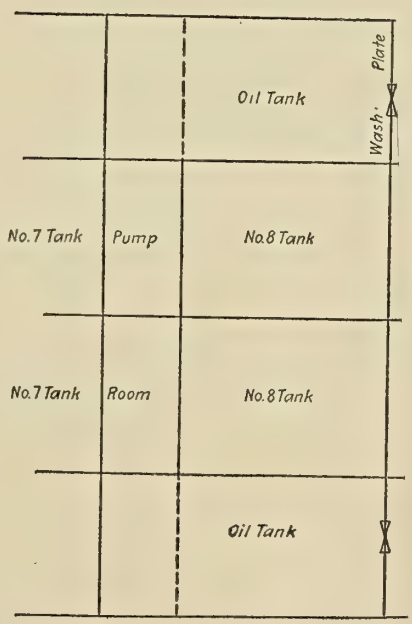


Fig. 1.—J. Foster King Type Tanker: Length Overall, 455 Feet 1 Inch; Length Between Perpendiculars, 440 Feet; Beam, Molded, 57 Feet 2 Inches; Depth to Upper Deck, Molded, 33 Feet 11 Inches; Deadweight Carrying Capacity, 10,100 Tons

ANKER





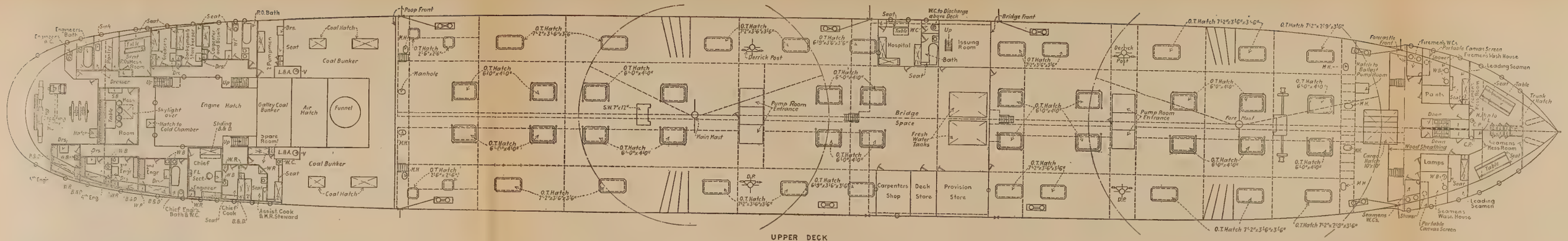


SOLE

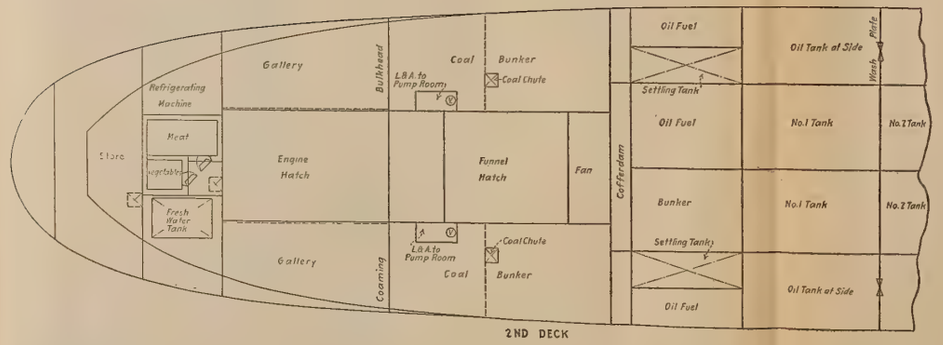
90 fathoms 7½-inch Manilla

Fig. 3.—Midship Section

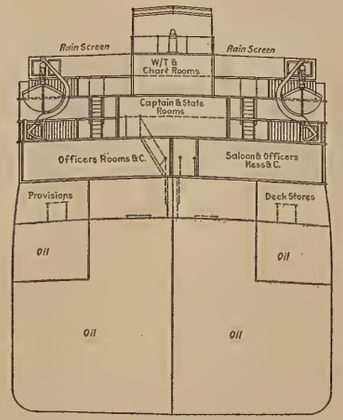
NEW DESIGN OF 10,000-TON TANKER



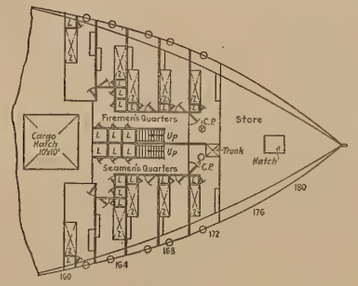
UPPER DECK



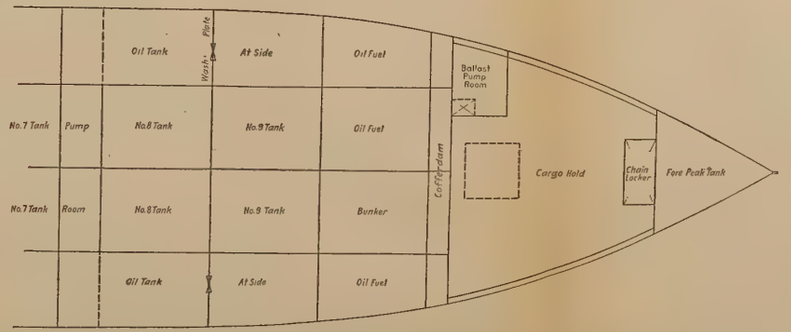
2ND DECK



SECTION



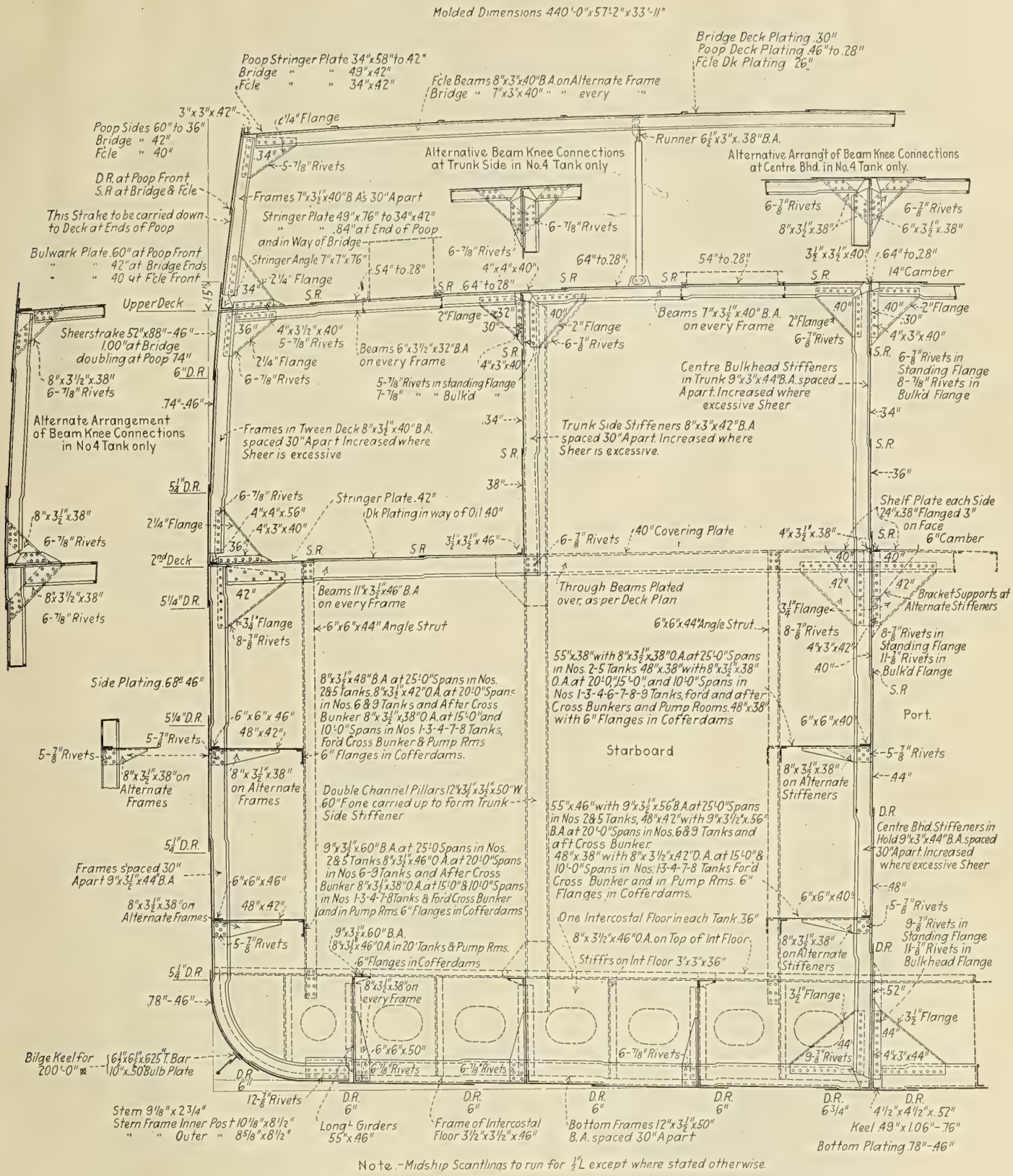
CABIN SOLE



2ND DECK

Fig. 2.—Deck Plans

90 fathoms 7½-inch Manilla



PARTS OF STRUCTURE ARRANGED FOR HYDRAULIC RIVETING

Bottom longitudinal girders; side longitudinal girders; center and transverse bulkhead girders; pillars; brackets to frames; intercostal floor in each tank; transverse bulkhead, bottom and wing plates to boundary bars; junction piece of center and transverse bulkheads; 'tween deck bulkhead at sides of trunk.

EQUIPMENT

1 bower anchor, stockless	83 cwts.
1 bower anchor, stockless	83 cwts.
1 bower anchor, stockless	70½ cwts.
1 stream anchor, ex stock	24 cwts.
1 kedge anchor, ex stock	10 cwts.
300 fathoms 2 6/16-inch stud chain cable	845.7
90 fathoms 1 5/16-inch stream chain or 4¾-inch S. W.	
130 fathoms 5½-inch S. W. towline	
90 fathoms 8½-inch Manilla	
90 fathoms 8½-inch Manilla	
90 fathoms 7½-inch Manilla	
90 fathoms 7½-inch Manilla	

EQUIPMENT TONNAGE

Tonnage under freeboard deck	6,389
Poop, bridge and forecastle	377
Casing	37
Deckhouse amidships	51
Deckhouse amidships	13.5
Wheelhouse, etc.	8.5
	6,876.0

Fig. 3.—Midship Section

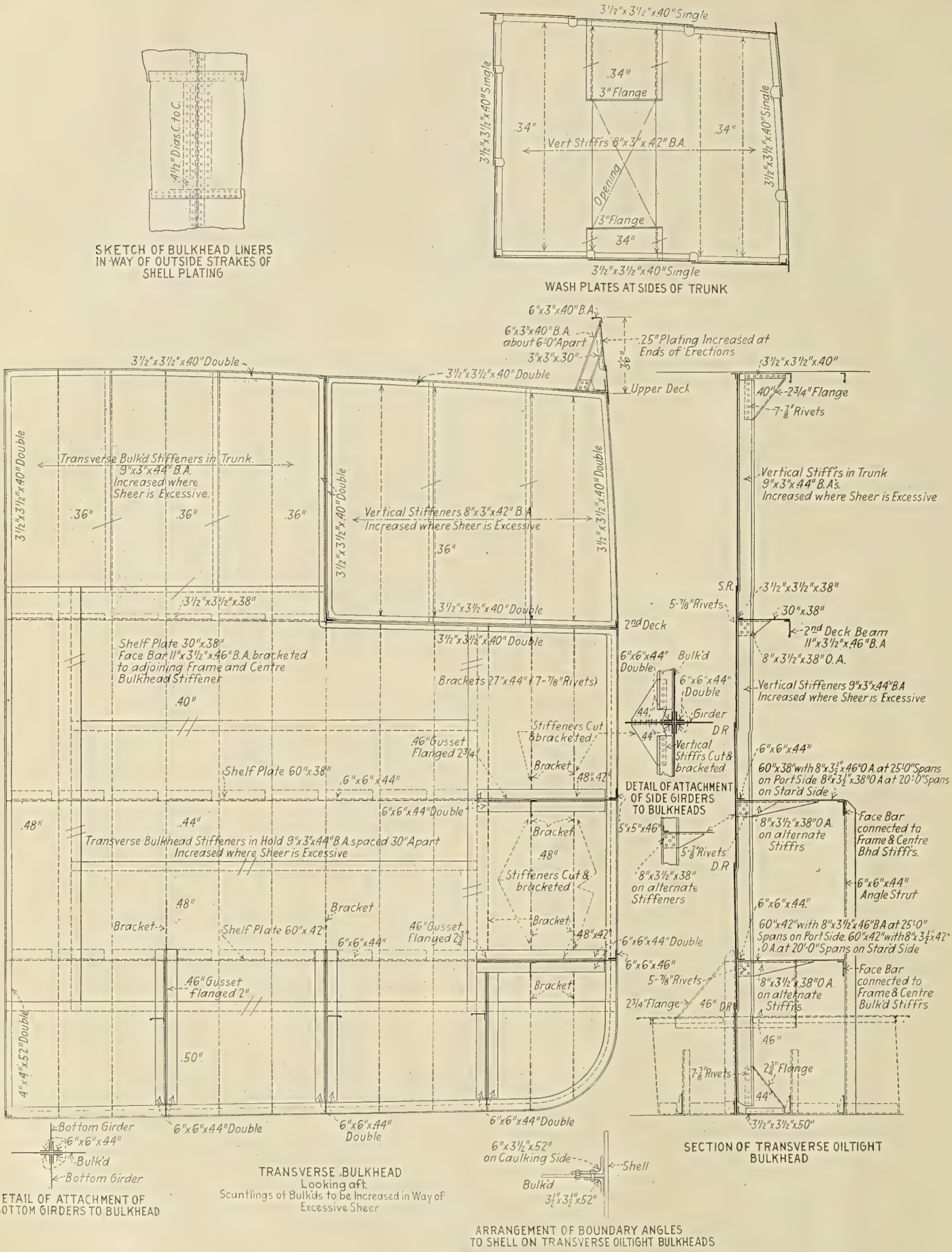


Fig. 4.—Bulkhead Details

furnaces being fitted for burning oil and coal. The boilers are of such size as will enable them to supply steam to various oil tanks for cargo heating, a complete system of heating coils being installed having sufficient heating surface to liquefy the heaviest class of oil carried.

Fuel Oil System

The fuel oil pumping arrangements have been well considered. A large transfer pump is fitted in the fore pump room capable of drawing fuel from the deep tank, fore peak and fore and after cross bunkers and discharging to deck or overboard as necessary. This piping is so arranged that oil can be pumped from any one of these tanks to any other. By this means a level keel can always be maintained irrespective of the class of cargo carried.

Two settling tanks, each containing one day's supply, are arranged at the after end of the summer tanks abreast the after cross bunker.

Arrangements are also being made for the burning of low flash oil, the details of which cannot be published at present, but which will be such as will meet the classification society and Board of Trade requirements and prove efficient in service.

Cargo Pumping Arrangement

Great attention has been paid to the oil pumping arrangements. The cargo oil is dealt with by three oil pumps, each capable of discharging 300 tons of oil per hour, even when pumping the heaviest class of oil. The oil piping is arranged so that the pumps can deal with the oil in every conceivable way, large double suction pipes being fitted to each tank, discharging to each side of the deck and over the stern, the total number of discharges being nine. Drain valves are fitted in the summer tanks, each of these valves being controlled from the upper deck.

The details of this system are all in accordance with the builders' latest and most approved practice.

A large ballast pump is placed in the forward ballast pump room for dealing with the water ballast in the fore deep tank and fore peak.

An efficient system of gas freeing and vapor pipes has been arranged throughout the oil compartments and every precaution taken to reduce the possibility of fire due to dangerous gases.

Electrical Installation

The electrical installation consists of two steam-driven generating plants, each dynamo being of ample size to run all lights, wireless, fans, steering gear, workshop machinery, etc., without heating.

Electric fans, bells and telephones are fitted throughout the vessel.

Life saving appliances are of the most up-to-date type, Welin davits being fitted for working the four lifeboats and motor launch.

The usual deck machinery is installed, the principle departure from the average tank vessel being that an electric hydraulic steering gear is fitted on the rudder head and controlled from amidships by telemotor gear.

The fittings throughout the vessel will be of first class make and description and there is little doubt that the vessels, when completed, will prove to be highly successful and efficient.

Electric Steering Gear on Standard Oil Company Barges

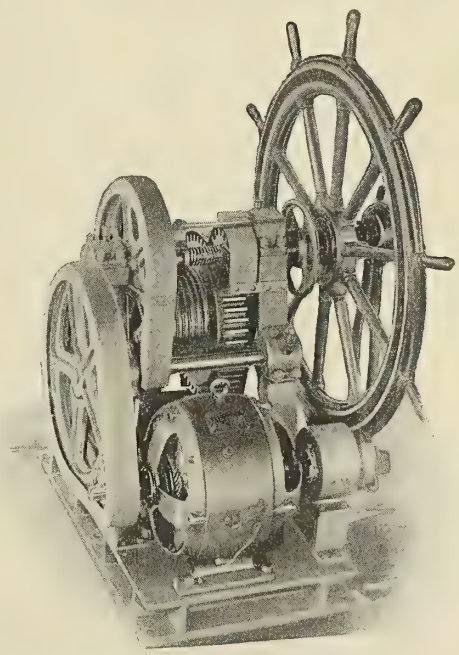
THE three steel barges *Buffalo Socony, Rochester Socony* and *Utica Socony* built for the Standard Oil Company of New York by the Bethlehem Shipbuilding Corporation, Limited, present two notably outstanding features in that they are self-propelled and electrically steered. They are designed to carry oil in bulk and will be placed in service on the New York State Barge Canal.

These barges are 156 feet long and are listed at 690 tons deadweight. They are driven through a single screw, and the propelling power is furnished by an oil engine which also runs a generating set of sufficient size to furnish the electricity required to operate the electric steering gear.

The electric steering gear is of the drum type, specially designed to combine light service with a very compact arrangement, giving flexibility of installation and economy of space. It was designed by the auxiliary machinery department of the Bethlehem Shipbuilding Corporation, Limited, and built at their Moore plant, Elizabethport, N. J. All working parts of the steerer, including the motor and brake, master switch, drum, handwheel and the required gearing, are mounted on a single base measuring 25 inches by 41¾ inches. This compact arrangement makes it possible to place the entire gear in the pilot house.

The motor which drives the steering gear is of the compound wound, direct current type, rated at 3 horsepower, 110 volts. It is provided with ball bearings and is suitable for 100 percent overload for five minutes. The motor is controlled by means of a magnetic control panel operated by a master switch at the steering stand. A shift of the master switch to the right or left causes the motor to be operated through the magnetic panel in the required direction. Power is transmitted from the motor through triple gears and drum to the quadrant on the rudder stock by means of a ¾-inch extra flexible steel wire rope. When the switch is brought back to the central, or off, position, the line is disconnected and the motor is stopped by means of a quick-acting shunt brake. Electrical dynamic braking is also provided.

A rudder indicator mounted on the framework of the steerer shows the position of the rudder at all times. When



Bethlehem Electric Steering Gear

the rudder reaches a hardover position a gear limit switch disconnects the power, stops the motor and prevents damage due to operating the steering gear beyond the working rudder angle.

The steerer is provided with a 60-inch handwheel for use

when it is desired to steer by hand. Shifting from electrical steering to hand steering is accomplished by moving a clutch wheel, which shifts two jaw clutches so that when the hand steering wheels are connected to the drum the motor is simultaneously disconnected, and vice versa. When the gear is connected up for hand steering the clutch is held in place by a spring latch, so that when it is desired to shift to electrical steering the spring latch is raised and a steel coil spring automatically moves the clutches to the required position. This renders it impossible for the motor and handwheel to be connected to the drum at the same time and eliminates all danger of accidents from this source.

This type of electric steering gear is suitable for service on river barges, yachts or any other light draft vessels.

The Motorship Narragansett

10,000-Ton Tanker Equipped With Oil Engines Using the Vickers System of Solid Injection of Fuel Oil

THE *Narragansett,* a motor-driven oil tank vessel built by Messrs. Vickers, Limited, at Barrow-in-Furness for the Anglo-American Oil Company, Limited, carries 9,420 tons of cargo plus 520 tons of fuel and stores.

Principal Dimensions

The principal dimensions of the vessel are as follows:

Length between perpendiculars	425 feet 0 inches
Breadth, molded	56 feet 8 inches
Depth to upper deck, molded	33 feet 0 inches
Mean draft	26 feet 0 inches
Displacement at mean draft	14,000 tons
Deadweight capacity	10,050 tons
Contract speed	10.5 knots
Speed on trial over measured mile	11.24 knots

The hull is constructed on the Isherwood system with a long poop and a short bridge and forecastle with connecting gangways. Fuel bunkers are arranged abreast of the machinery space on the tank deck aft and there are ten main tanks for oil fuel.

Main Engines

Two Vickers six cylinder four cycle solid injection motors are installed aft, each developing normally 1,250 brake horsepower at 118 revolutions per minute and having cylinders 24½ inches diameter and 39 inches stroke.

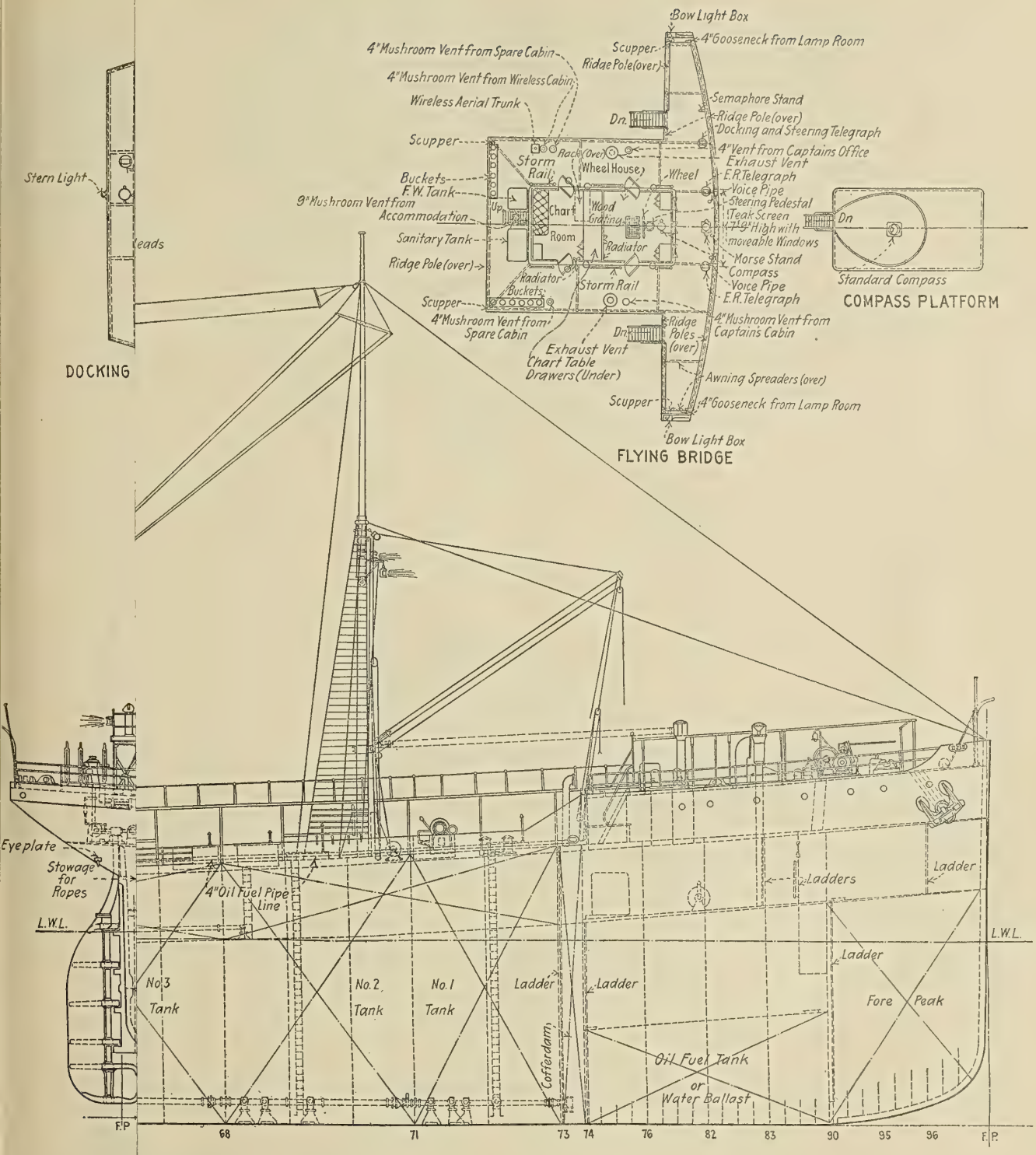
Heavy cast iron columns are employed for the framing, representing a modified submarine trestle design with columns over the main bearing, the columns being continuous athwartships, although relatively thin between the front and back. Within these hollow columns are long steel tie-rods and the cylinders are separately cast and bolted together.

The liners and cylinder covers, which are separate, are of special cast iron, and a feature of note is the provision of diaphragm plates under the cylinders to prevent waste of lubricating oil. The liners are free to expand downwards.

Fuel Oil System

The engines are fitted with the Vickers patent system of solid injection of fuel oil which entirely dispenses with the use of compressed air for fuel injection purposes. The principle lies in forcing fuel oil at about 4,000 pounds per square inch into the cylinder through a special type of valve in the cylinder cover. The fuel is supplied under this pressure by means of a small battery of four pumps discharging to a common rail with branches leading to each cylinder.

Fig. 1.—10,000-Ton Motor Tanker *Narragansett* on Her Trial Trip



; Designed Speed, 10.5 Knots

THE MOTORSHIP NARRAGANSETT

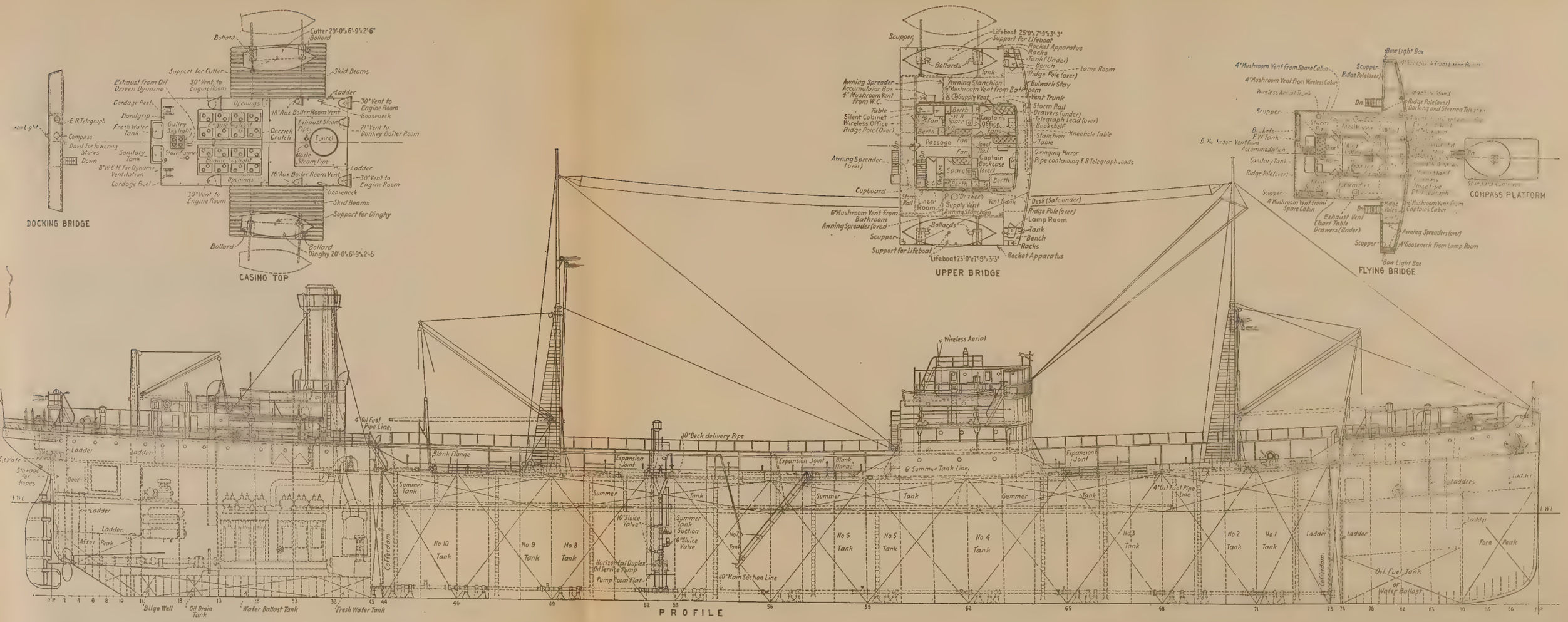
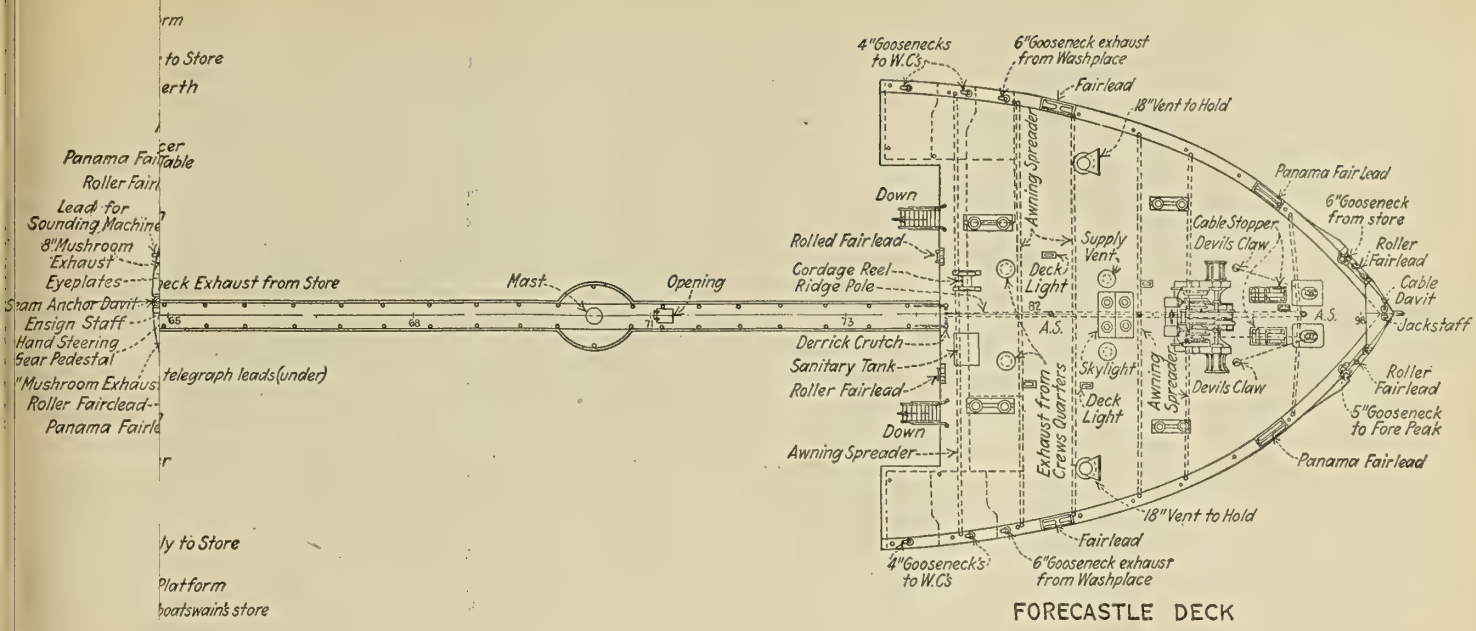
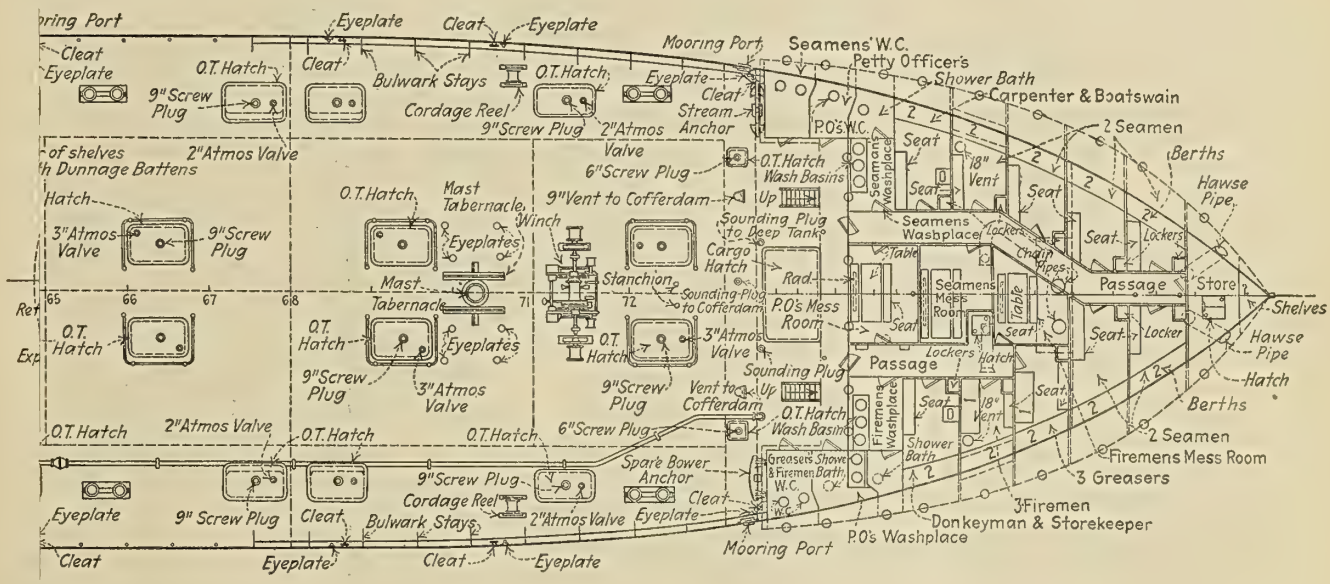
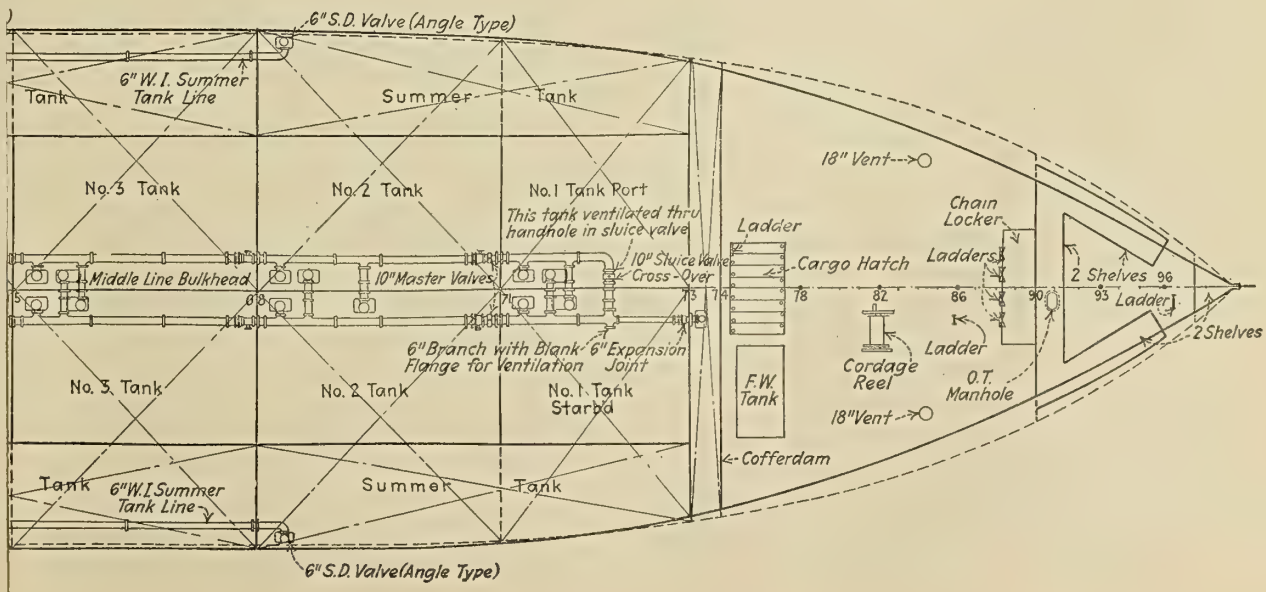


Fig. 2.—Profile and Bridge Deck Plans: Length Between Perpendiculars, 425 Feet; Beam, Molded, 56 Feet 8 Inches; Depth to Upper Deck, Molded, 33 Feet; Mean Draft, 26 Feet; Deadweight Capacity, 10,050 Tons; Designed Speed, 10.5 Knots


4"Gooseneck to W.C's
6"Gooseneck exhaust from Washplace
Fairlead
18"Vent to Hold
Panama Fairlead
6"Gooseneck from store
Roller Fairlead
Cable Davit
Jackstaff
Panama Fairlead
Roller Fairlead
Lead for Sounding Machine
8"Mushroom Exhaust
Eyeplates
Ensign Staff
Hand Steering Gear Pedestal
Mast
Opening
Down
Rolled Fairlead
Cordage Reel
Ridge Pole
Derrick Crutch
Sanitary Tank
Roller Fairlead
Awning Spreader
Supply Vent
Deck Light
Skylight
Cable Stopper
Devil's Claw
Exhaust from Crews Quarters
5"Gooseneck to Fore Peak
Panama Fairlead
18"Vent to Hold
Fairlead
4"Gooseneck's to W.C's
6"Gooseneck exhaust from Washplace
FORECASTLE DECK


Mooring Port
Seamens' W.C.
Petty Officer's
Shower Bath
Carpenter & Boatswain
2 Seamen
Berths
Hawse Pipe
Cleat
Eyeplate
O.T. Hatch
9" Screw Plug
Bulwark Stays
Cordage Reel
2"Atmos Valve
Stream Anchor
P.O's W.C.
Seat
18" Vent
Seamens Washplace
Seamens Mess Room
Passage
Store
Shelves
Hawse Pipe
Hatch
Berths
2 Seamen
Firemens Mess Room
3 Greasers
3 Firemen
Donkeyman & Storekeeper
P.O's Washplace
Mooring Port
6"Screw Plug
Wash Basins
Sounding Plug to Deep Tank
Cargo Hatch
Mast
Tabernacle
Winch
Stanchion
Eyeplates
3"Atmos Valve
9"Vent to Cofferdam
Sounding Plug to Cofferdam
Vent to Cofferdam
Spare Bower Anchor
Cofferdam


6" S.D. Valve (Angle Type)
6" W.I. Summer Tank Line
Tank
Summer
No. 3 Tank
No. 2 Tank
No. 1 Tank Port
This tank ventilated thru handhole in sluice valve
Middle Line Bulkhead
10" Master Valves
10" Sluice Valve Cross-Over
6" Branch with Blank Flange for Ventilation
6" Expansion Joint
No. 3 Tank
No. 2 Tank
No. 1 Tank Starbd
Ladder
Cargo Hatch
18" Vent
Chain Locker
Ladders
2 Shelves
Ladder
Cordage Reel
O.T. Manhole
F.W. Tank
Cofferdam
6" S.D. Valve (Angle Type)

THE MOTORSHIP NARRAGANSETT

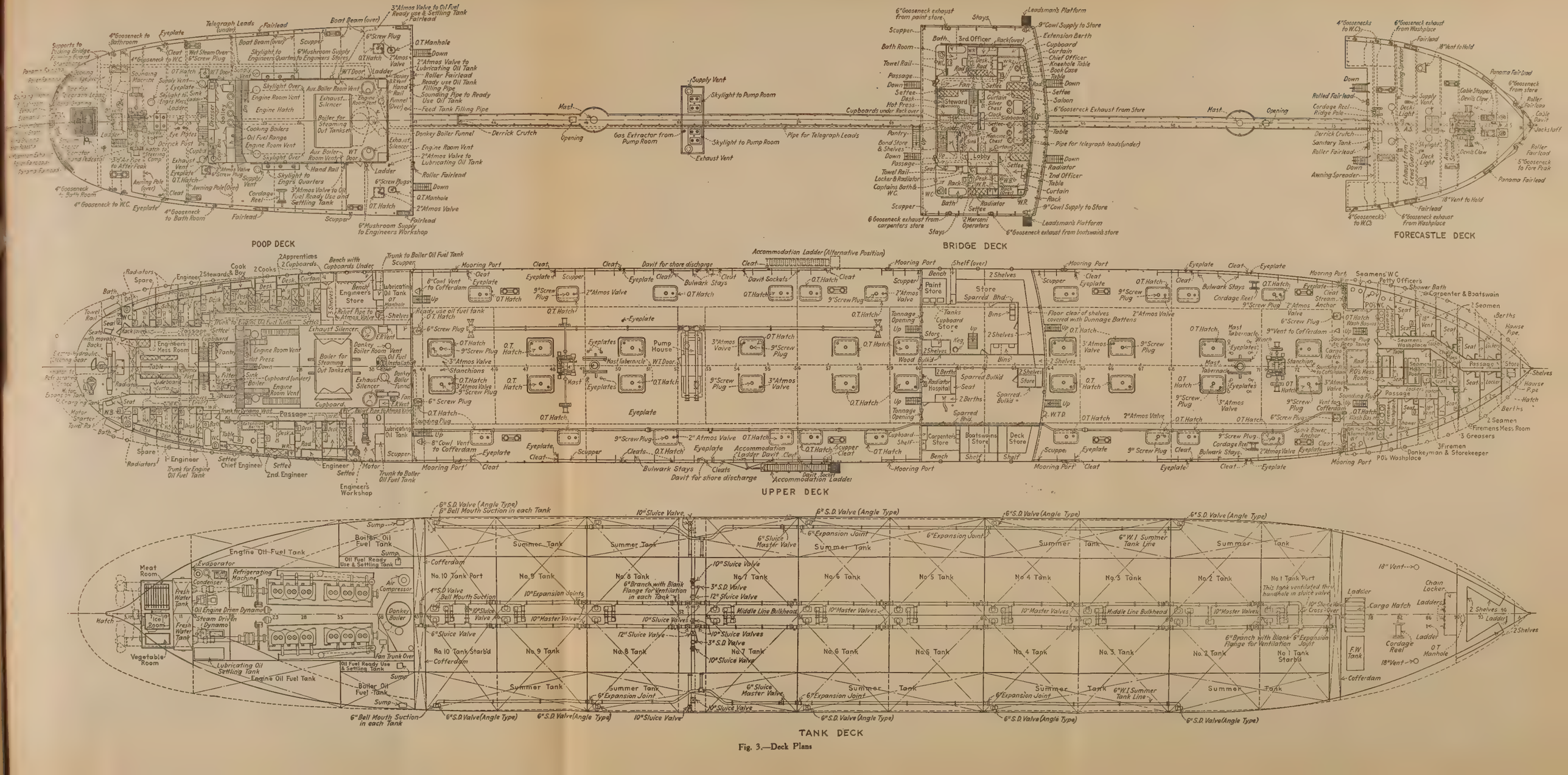


Fig. 3.—Deck Plans

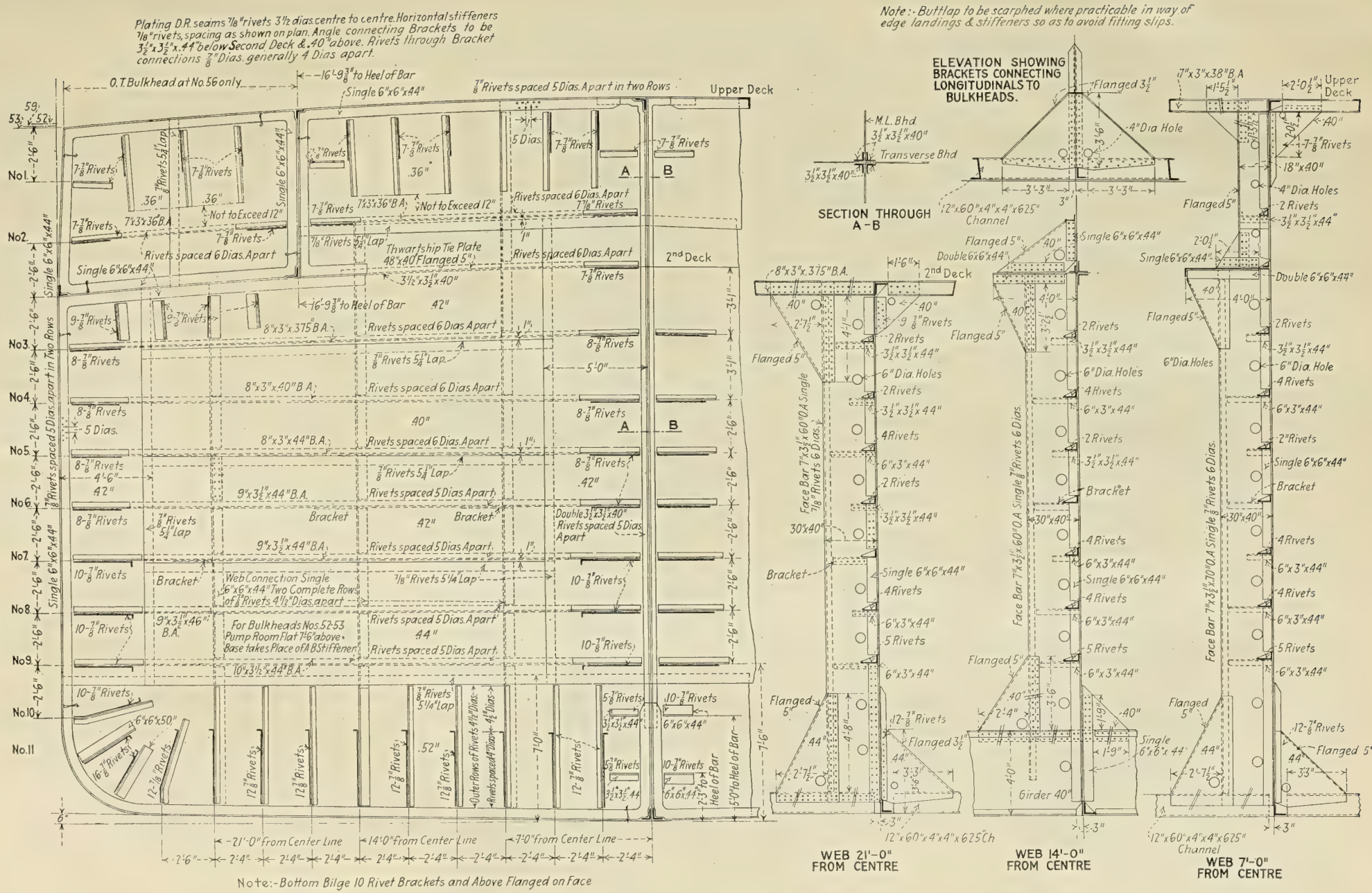


Fig. 4.—Bulkhead Details

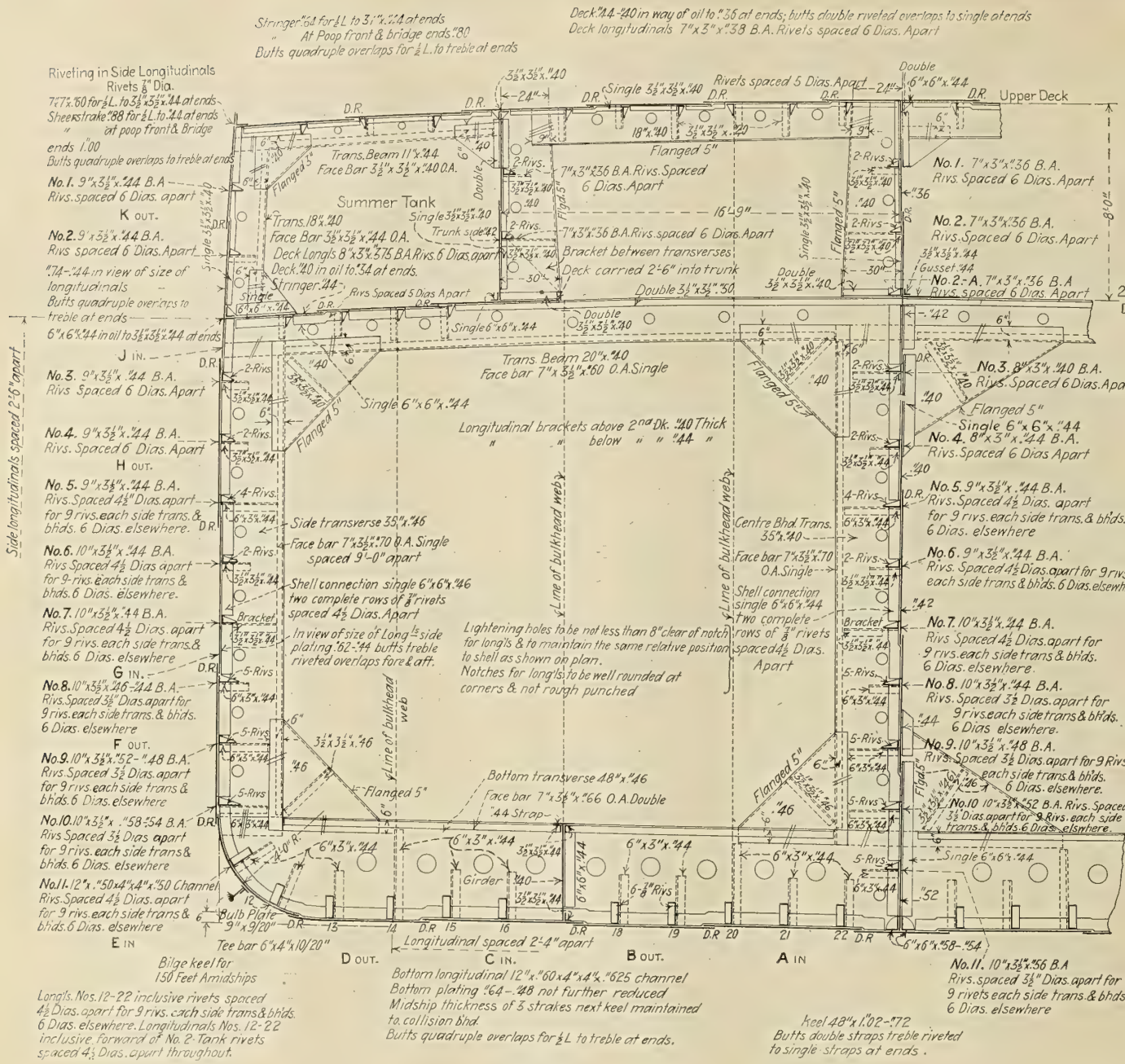


Fig. 5.—Midship Section

Control Mechanism

The control of the pressure of oil fuel is effected by regulating the closing point of the suction valves of the pumps.

The camshaft is driven by spur and bevel gearing from the center coupling of the crankshaft.

Reversibility is obtained by the sliding camshaft method, two side by side cams being provided for each valve. The valves are operated by levers mounted on the maneuvering shaft and actuated by the cams on the camshaft. The gear is placed in the reverse position by means of a servo-motor comprising a compressed air power cylinder and an oil buffer cylinder. Suitable mechanism is arranged between the servo-motor and the fulcrum and camshafts, so that when the servo-motor operates all the movements required for reversing are carried out in their proper order. A hand reversing gear is provided for use in the event of failure of the power cylinder, in the form of a hand pump operating on the oil buffer cylinder.

All the essential controls are interlocked, and only when the complete movements have been effected is it possible to operate the starting wheel. Rotating of the starting wheel first admits compressed air to all cylinders; further rotation cuts off air and admits fuel to the cylinders in pairs.

A hand lever is provided at the control station for controlling the speed of the engine, which is effected by regulating the opening of the fuel valves.

Cooling System

Salt water is used for both the cylinder and piston cooling, this water being supplied by pumps worked by sway beams from the forward crosshead of each engine. Above the main pumps are mounted booster pumps to give additional pressure to the piston cooling water. Bilge and sanitary pumps are also worked by the sway beams. The supply to the pistons is taken through telescopic pipes, and the outflow is taken to funnels mounted on the columns.

Lubrication

Forced lubrication is applied to all the crankshaft and crosshead bearings by means of two electrically driven reciprocating pumps. For the lubrication of the pistons, force pumps of the sight feed multiple plunger type are provided.

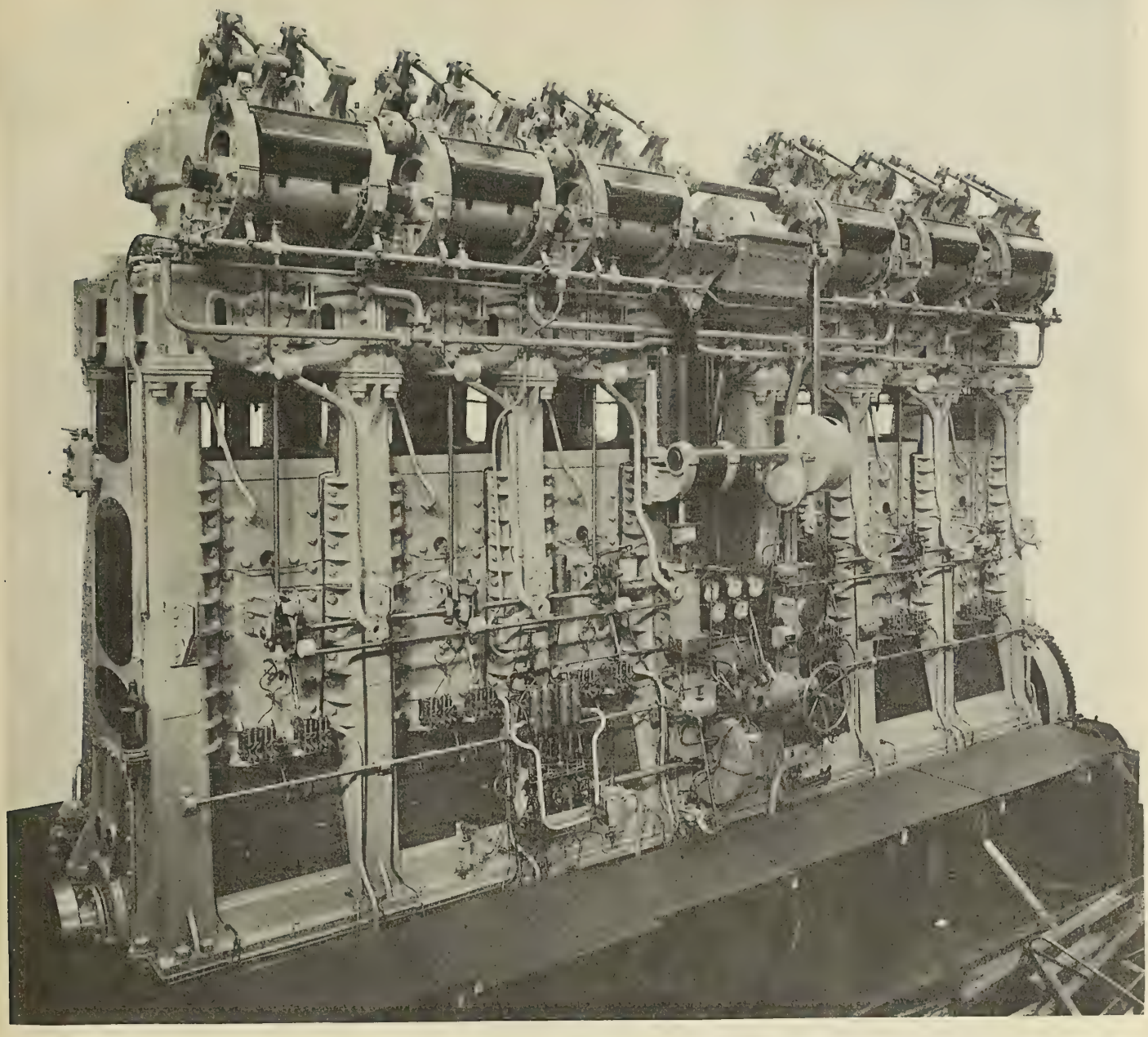


Fig. 6—Vickers Six-Cylinder Solid Injection Motor. Two of These Motors, Developing 1,250 Brake-Horsepower Each, Are Used to Drive the *Narragansett*

Auxiliaries

The bulk of the auxiliary machinery is steam driven. For the provision of the steam there is a Cochran boiler at the forward end of the engine room, while another boiler is situated at a higher level, both of these being oil fired. When at sea the small donkey boiler only is required, being sufficient for ordinary heating purposes and for the auxiliary steam plant such as the dynamo or compressor.

The steam-driven auxiliaries in the engine room comprise two Brotherhood compressors for providing starting air, together with two sets of fire and bilge pumps.

Electric Plant

At the after end of the engine room is the electrical plant comprising a steam engine driving a dynamo and a Vickers Petter semi-Diesel motor of 38 horsepower also driving a dynamo. These supply electric power for lighting and steering and also for one or two pumps.

The steering gear is of the Vickers variable speed gear type operating on the electric-hydraulic principle.

There are two steam-driven cargo pumps having a capacity of 200 tons per hour each. The capstan and the two 7-inch by 10-inch winches forward and one 8-inch by 12-inch winch aft are also steam driven.

The galley, designed to cook for fifty people, is oil fired.

Performance of the Vessel

The performance of the vessel on service has been in every way satisfactory and the following particulars of the run back from New Orleans to Liverpool, July, 1920, on maiden voyage, show the fuel consumption, etc., on a long sea voyage:

Total distance	4,528 nautical miles
Running time (approximately)	17 days
Average speed (actual)	11.1 knots
Mean revolutions per minute (as designed)	118
Engine fuel used per day	9.61 tons
Boiler fuel used per day	2.13 tons
Total fuel consumption per day	11.74 tons

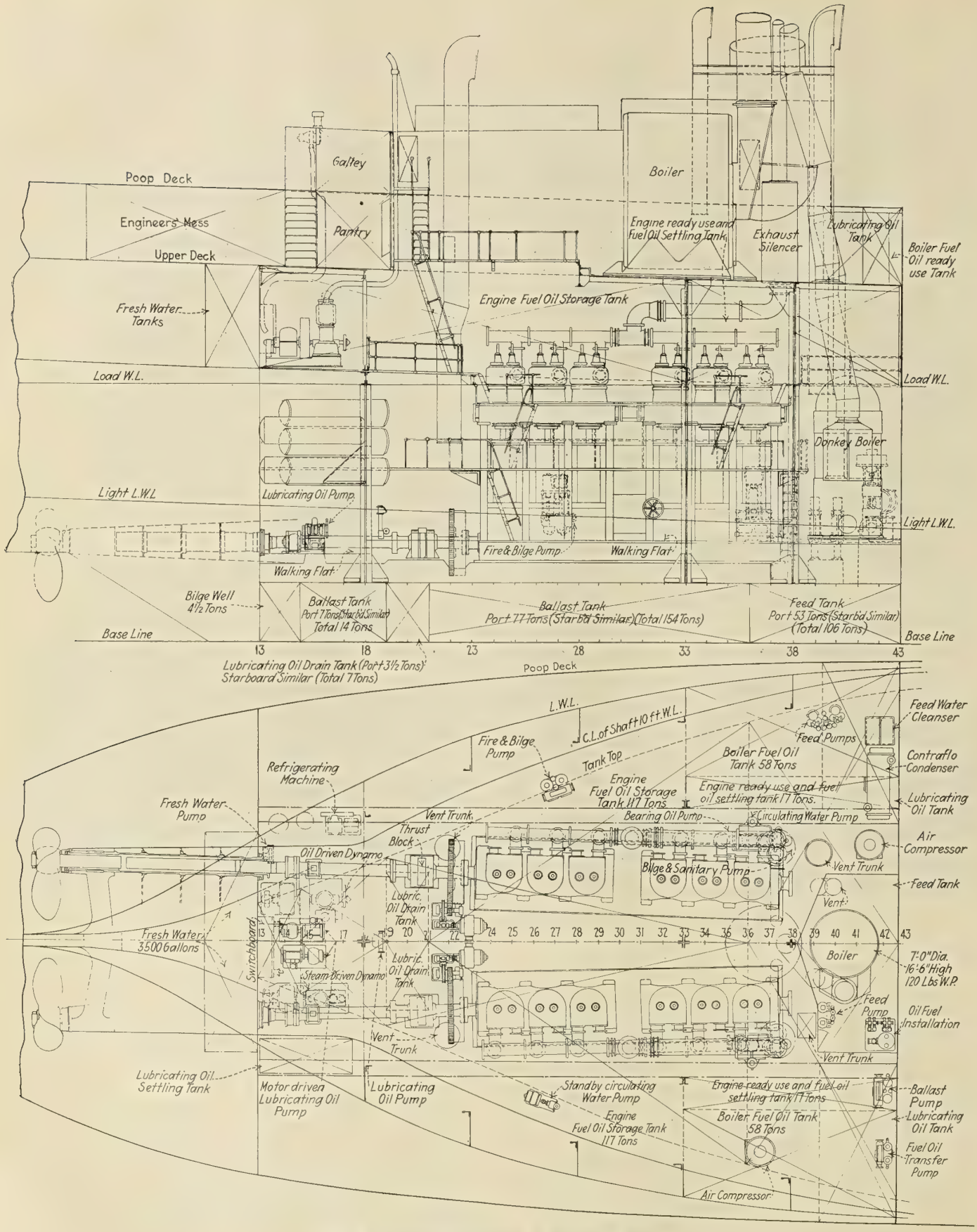


Fig. 7.—Plan and Elevation of Machinery Space

According to information received from owners regarding similar oil fired steam vessels, the average speed is 10.25 knots and the daily consumption of oil 35 tons, while the daily consumption of fuel in a coal fired steam tanker very slightly larger than the *Narragansett* is 55 tons at 9.8 knots speed.

Sixteenth Annual Motorboat Show Successful

THE National Association of Engine and Boat Manufacturers held its sixteenth annual exhibition at the Grand Central Palace, New York, December 10 to 18. Exhibits were presented by 113 members of the association which included nearly every type of high and low powered motor boats, engines for speed boats, heavy duty motors, and marine accessories of all kinds that might in any way be applied to the needs of commercial and pleasure craft. Developments in the field have been rapid during the past two years, and the latest hull designs of various builders were a special feature of the show. On the main floor of the exhibit about twenty-five boats ranging from 10-foot dories to 60-foot cruisers were arranged with ladders and platforms, so that visitors might climb aboard and investigate the arrangements and equipment.

The *Rainbow,* winner of the first race for the Fisher trophy at Detroit last year, and the *Tarpon,* especially built for the second trophy event to be staged at Miami, Fla., in February, were exhibited side by side. Together with racing motors and light weight high powered engines for fast pleasure craft, many of the exhibitors presented heavy duty gasoline, kerosene and heavy oil engines for inspection.

The Mianus Motor Works, Stamford, Conn., exhibited several improved Diesel heavy oil engines, including a 60-horsepower, 4 cylinder model and a 30-horsepower, 2 cylinder engine with smaller types of 15 horsepower and 7½ horsepower.

The Winton Engine Works, Cleveland, Ohio, exhibit contained three complete units, model W-5, a 125-horsepower engine, model W-2, a generator set, and model 85 water and air pump. The marine motor has six 8-inch cylinders and a stroke of 11 inches, a crank shaft diameter of 3½ inches, main end bearing 3½ inches by 9 inches, interior bearings 3½ inches by 5½ inches, connecting rod bearing 3½ inches by 4⅛ inches, a speed range of 100 to 450 revolutions per minute and a weight of 10,000 pounds. The generating set consists of a six cylinder 3-inch by 4-inch engine driving a 7½-kilowatt Imperial generator at 1,200 revolutions per minute, which delivers current at 110 volts.

The Dodge Sales & Engineering Company, New York City, showed a 4 cylinder 50-horsepower heavy oil engine.

Buffalo heavy duty oil engines were also shown.

The Wolverine Motor Works, Bridgeport, Conn., exhibited a 6 cylinder 11-inch diameter by 15-inch stroke 200-horsepower outfit and a 3 cylinder 42-horsepower 8½-inch by 9-inch engine. Both of these engines are designed to burn gasoline and equipped with high tension ignition systems.

The Van Blerck exhibit consisted of 4, 6 and 8 cylinder, high power, speed boat engines and a 4 cylinder, heavy duty commercial engine. All of the marine engines built by this company are equipped with a special fuelizer which makes it possible to control the engines from low to high speed and full load without back firing.

For large motor yachts the New London Ship & Engine Company, Groton, Conn., had developed the Nelseco Diesel engine, which can be built in units from 120 horsepower to 3,400 horsepower.

One of the largest engine exhibits at the show was that of Palmer Brothers Engines, Inc., of Cos Cob, Conn., which included heavy duty engines of 18, 35, 60 and 80 horsepower. These engines develop their rating at 300 to 400 revolutions per minute. In all the 4 cycle models, except the single cylinder, a multiple disk reverse gear is mounted on the base and the single cylinder size may be so equipped if desired.

The New York Yacht, Launch & Engine Company, Morris Heights, New York, exhibited a 4 cylinder, 40-50 horsepower and a 6 cylinder 65-75 horsepower twentieth century motor.

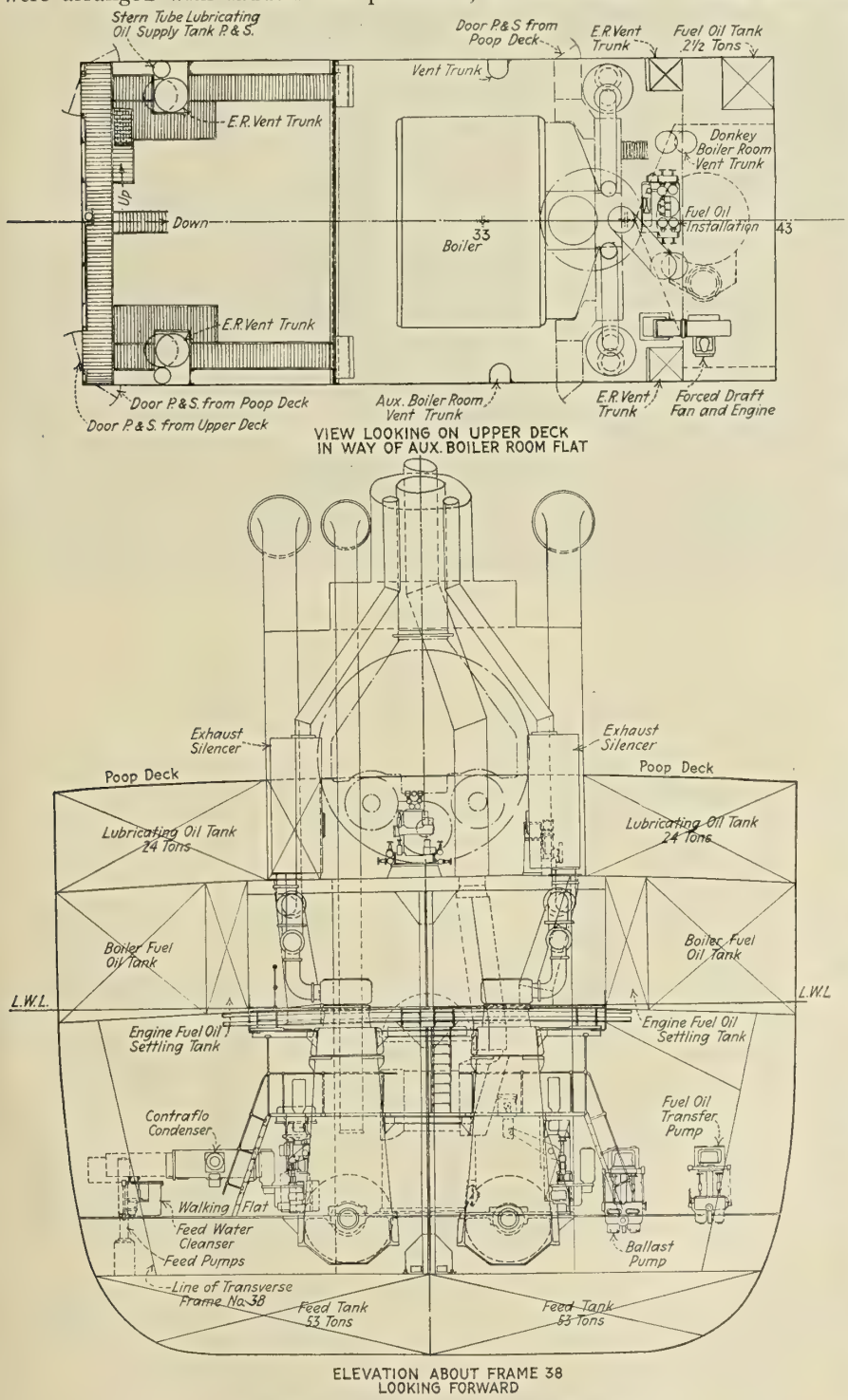


Fig. 8.—Section Through Engine Room

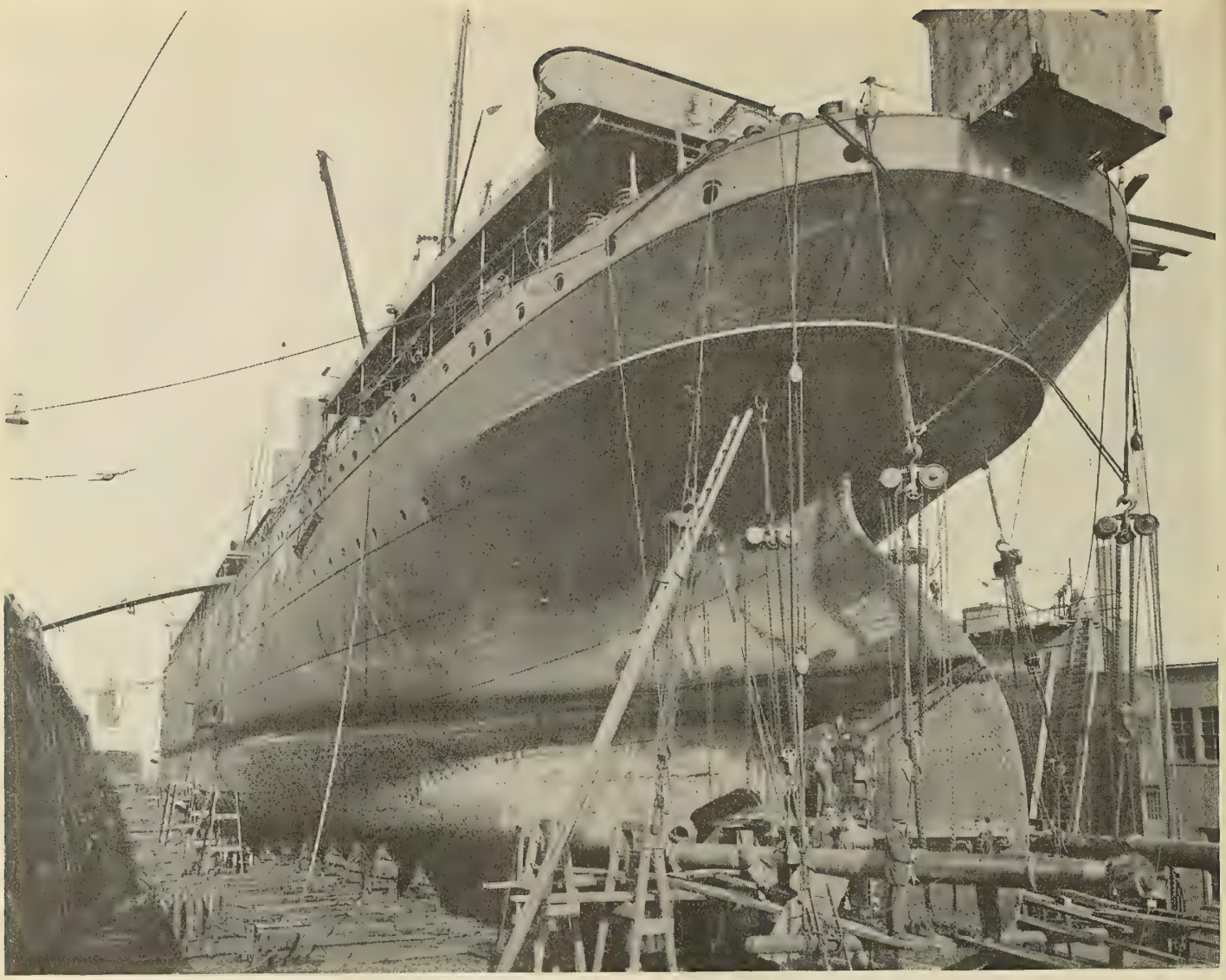


Fig. 1.—Fitting Propeller Shafting to the *Mount Clay* in Morse Dry Dock

Passenger Steamship Mount Clay

Reconversion of German Steamship DeKalb into Steerage Vessel with Large and Attractive Accommodations

BY JAMES A. KELLEY*

ONE of the largest reconversion contracts to be furnished in the United States up to the present time is the German built steamer *Mount Clay*, ex-*DeKalb*. This vessel was formerly the *Prinz Eitel Friedrich* and was built at the Vulcan Works at Stettin, Germany, in 1904. Before the United States declared war against Germany this vessel had a notorious career and featured in many daring exploits.

The vessel was taken over by the United States Government at the beginning of the war and did creditable service as an army transport.

The following are the dimensions of the vessel:

Length overall, 506 feet 6 inches; length between perpendiculars, 489 feet 2 inches; breadth, molded, 34 feet 10 1/16 inches; depth, molded, 34 feet 10 7/16 inches.

She is built on the transverse system, with deep channel frames with webs and stringers. The double bottom has a depth of 48 inches and extends the full length of the vessel. When built, the vessel was classed to the highest rating then given by the Germanischer Lloyds.

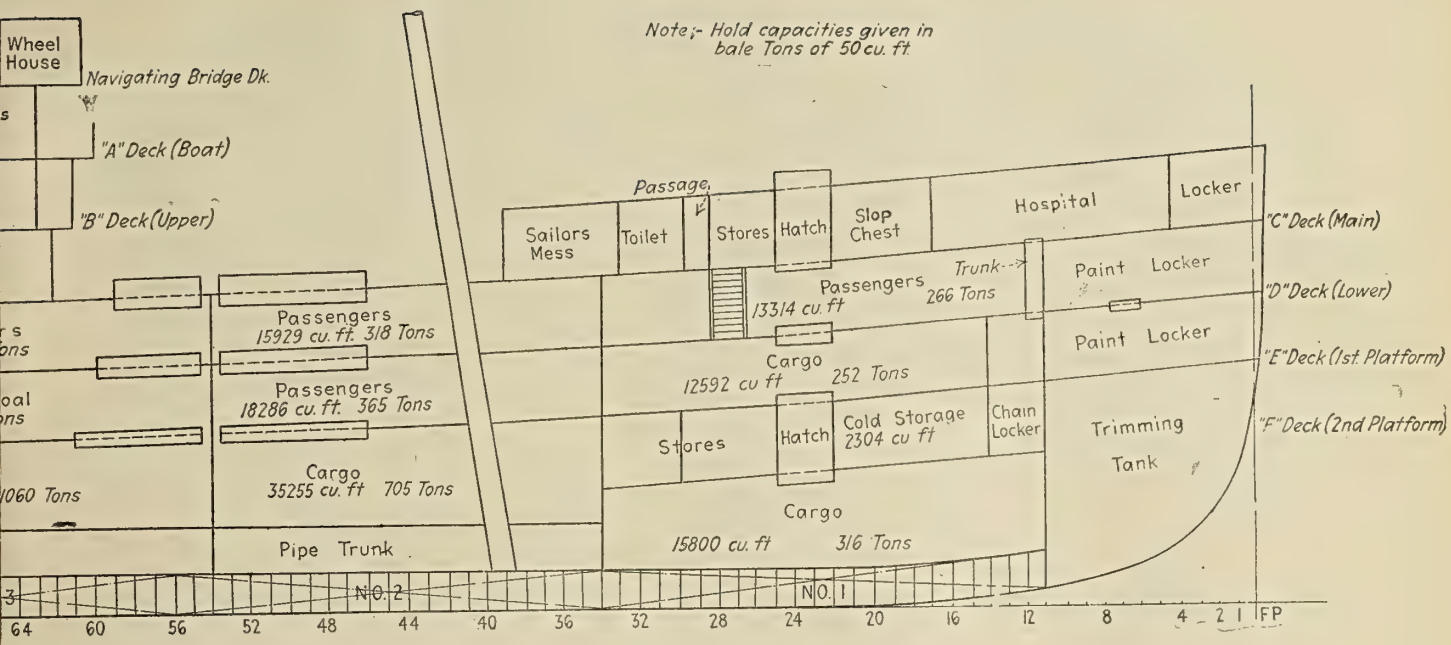
When the vessel arrived at the yard of the Morse Dry Dock & Repair Company she had been completely gutted by fire which occurred in the Hudson River at Spuyten Duyvil. The owners of the ship decided to convert her into a first class steerage vessel to carry the largest number of persons possible and at the same time to give the passengers larger and more attractive public rooms than are customary on this type of ship.

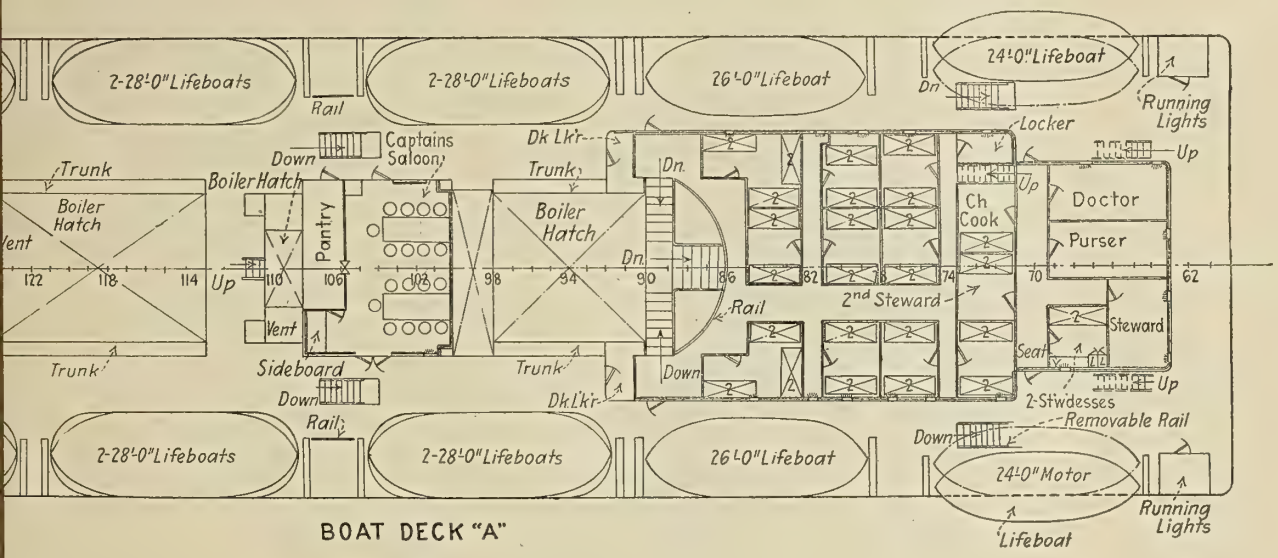
The navigating officers' wheel house and chart room are situated on the navigation bridge deck, the only deck which the steerage passengers will not be allowed to use. On this deck also are three special staterooms for use of various ship company's officers. These rooms are fitted up in elaborate style.

On the top deck is a large passenger promenade. The deck house contains large rooms for doctor, purser, steward and stewardess. The remainder of the deck house is given over to steerage passengers' use, containing four and six berths each. Between the two boiler casings will be found the cap-

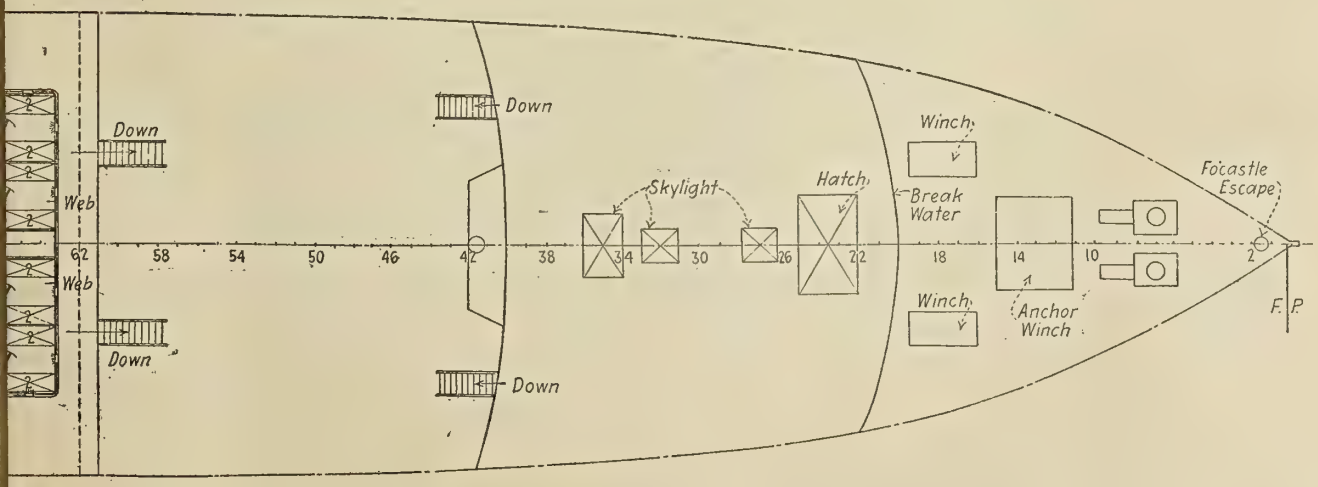
(*Continued on page* 78.)

* Naval architect, Morse Dry Dock and Repair Company, Brooklyn, N. Y





BOAT DECK "A"



h, Molded, 34 Feet 10 7/16 Inches

PASSENGER STEAMSHIP MOUNT CLAY

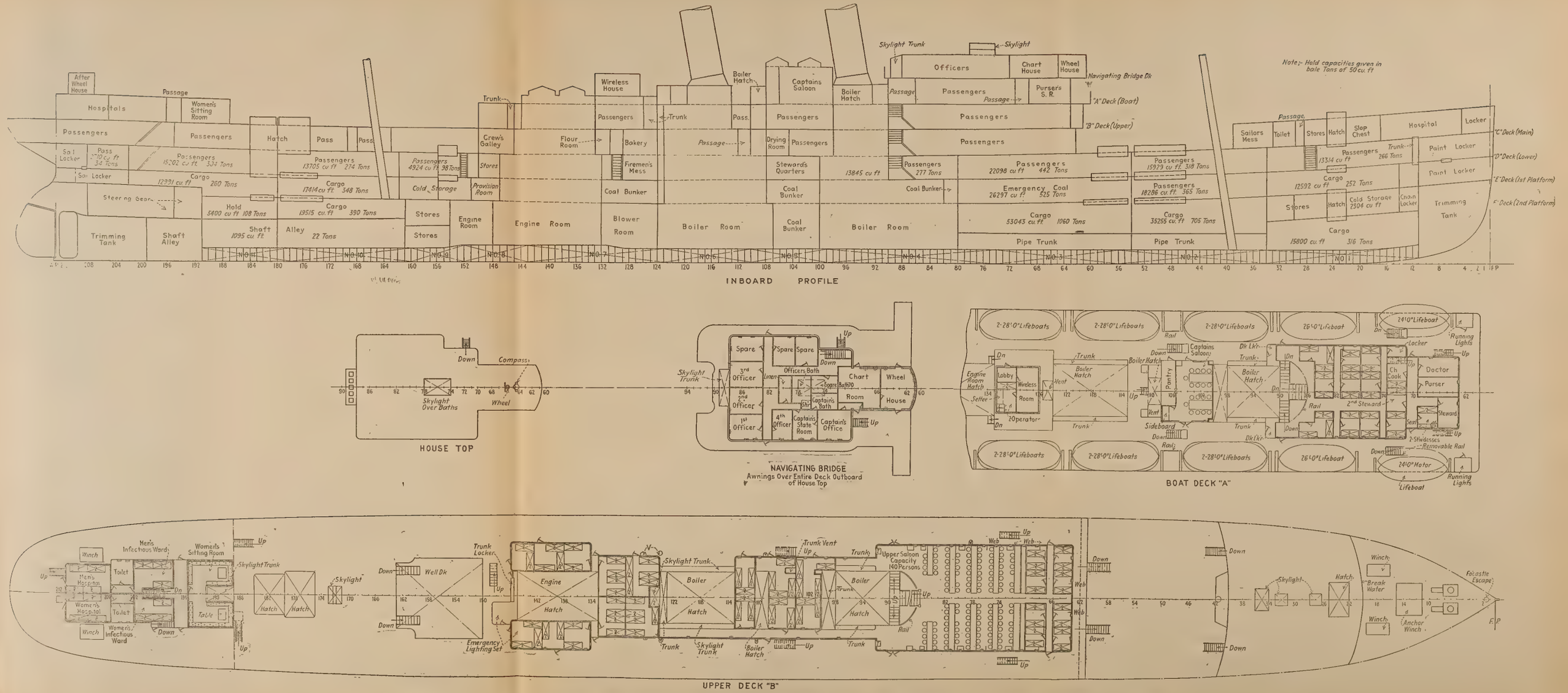
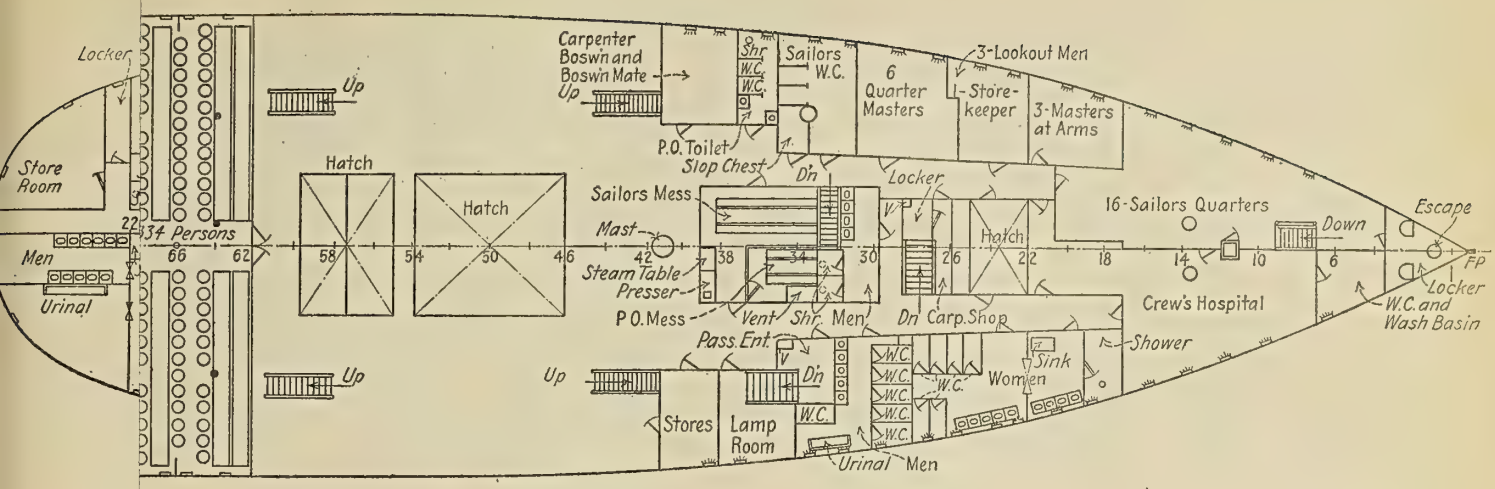
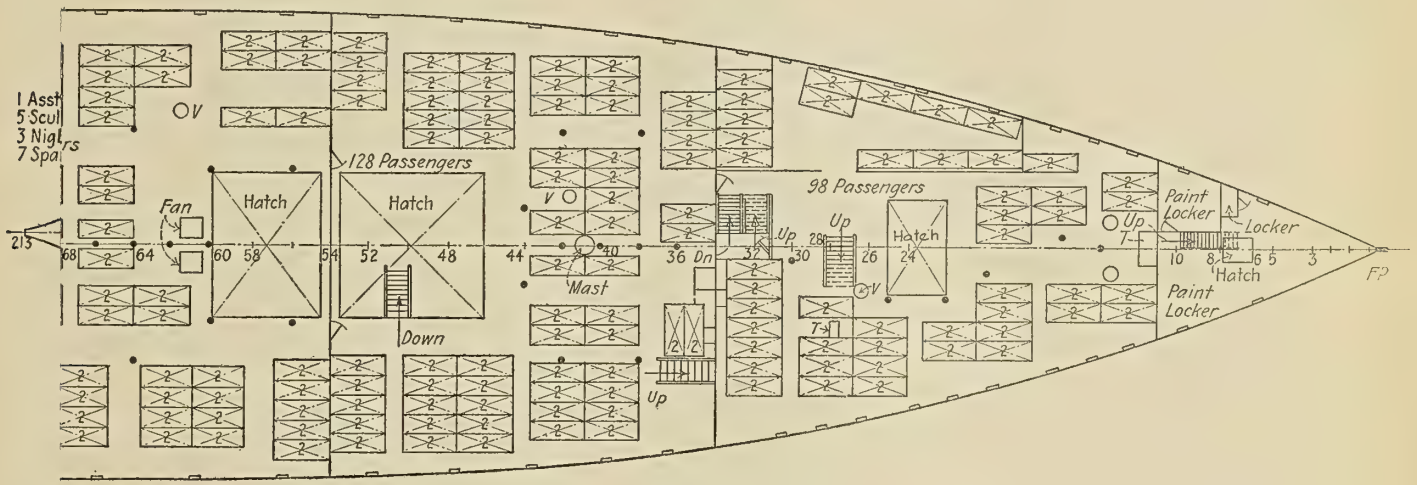
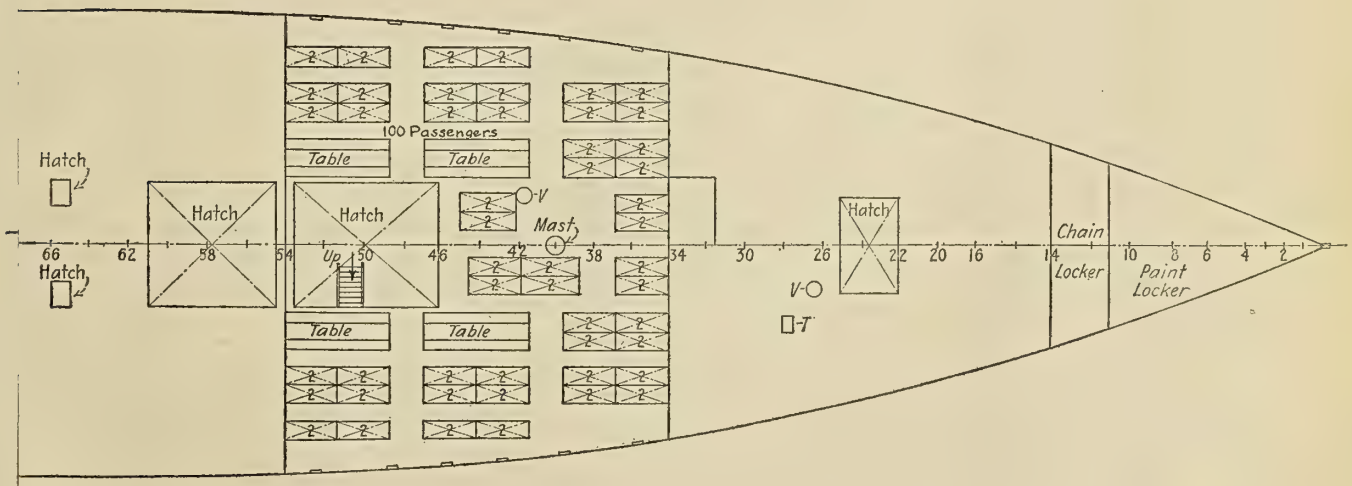


Fig 2.—Inboard Profile and Deck Plans of S. S. *Mount Clay*: Length Overall, 506 Feet 6 Inches; Length Between Perpendiculars, 489 Feet 2 Inches; Beam, Molded, 34 Feet 10 1/16 Inches; Depth, Molded, 34 Feet 10 7/16 Inches


Locker
Store Room
Men
Urinal
Up
Hatch
Hatch
134 Persons
Carpenter
Boswin and
Boswin Mate
Up
Shr
W.C.
W.C.
Sailors W.C.
6 Quarter Masters
3-Lookout Men
1-Store-keeper
3-Masters at Arms
P.O. Toilet
Slop Chest
Dn
Locker
Sailors Mess
Mast
Steam Table
Presser
P.O. Mess
Vent
Shr
Men
Dn
Carp. Shop
Hatch
16-Sailors Quarters
Down
Escape
Crew's Hospital
Shower
Locker
W.C. and Wash Basin
FP
Pass. Ent.
Up
Dn
Stores
Lamp Room
W.C.
Urinal
Men
Women
Sink


1 Asst
5 Scul
3 Nigl
7 Spa
128 Passengers
Fan
Hatch
Hatch
Down
Mast
98 Passengers
Up
Hatch
Paint Locker
Locker
Hatch
Paint Locker
FP
Up


Hatch
Hatch
100 Passengers
Table
Table
Hatch
Hatch
Mast
Up
Hatch
Table
Table
Chain Locker
Paint Locker

PASSENGER STEAMSHIP MOUNT CLAY

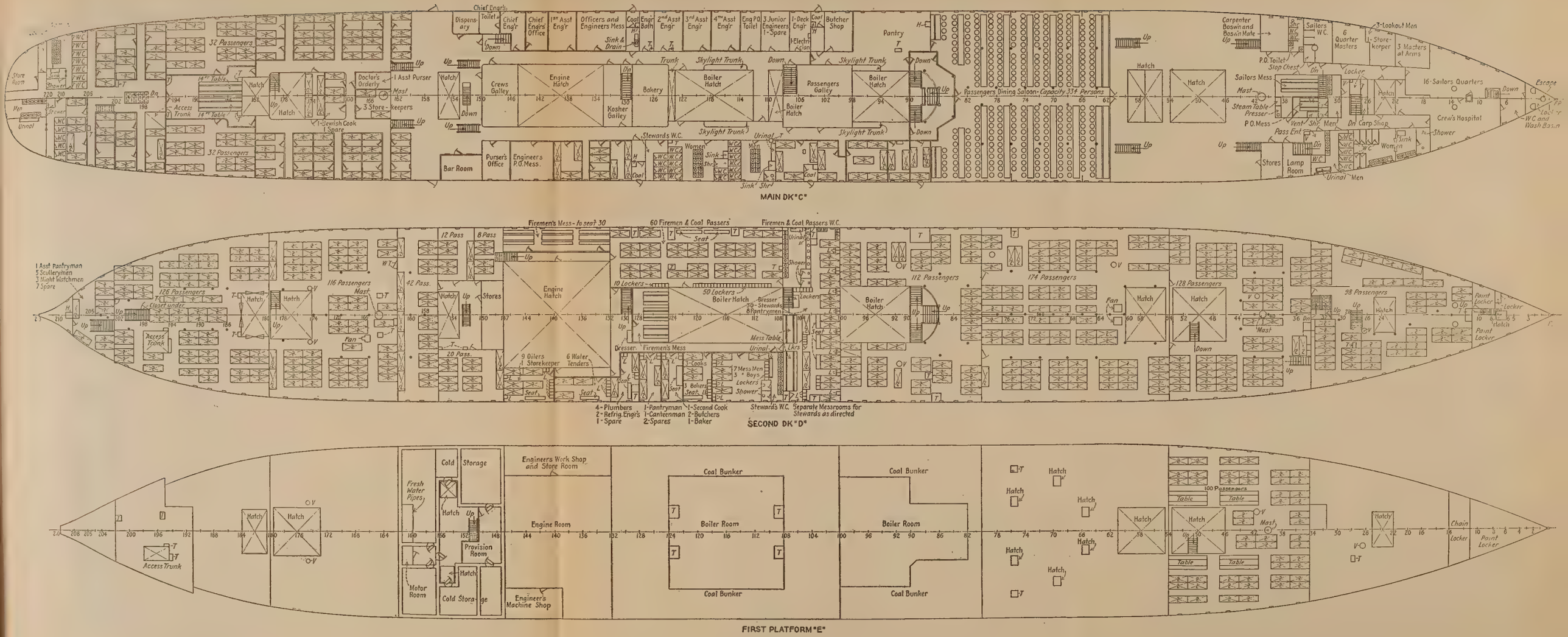


Fig. 3.—Deck Plans

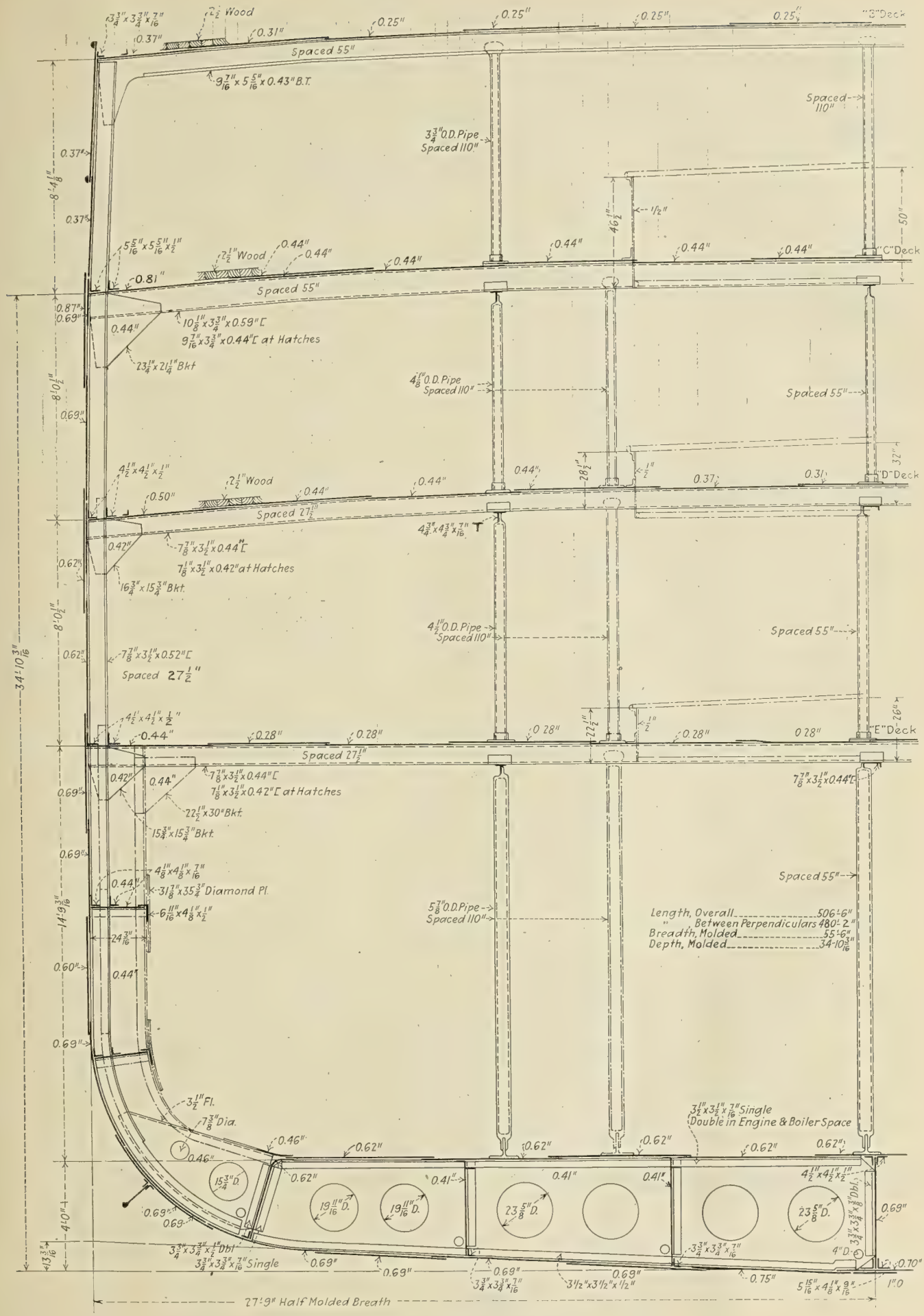


Fig. 4.—Midship Section

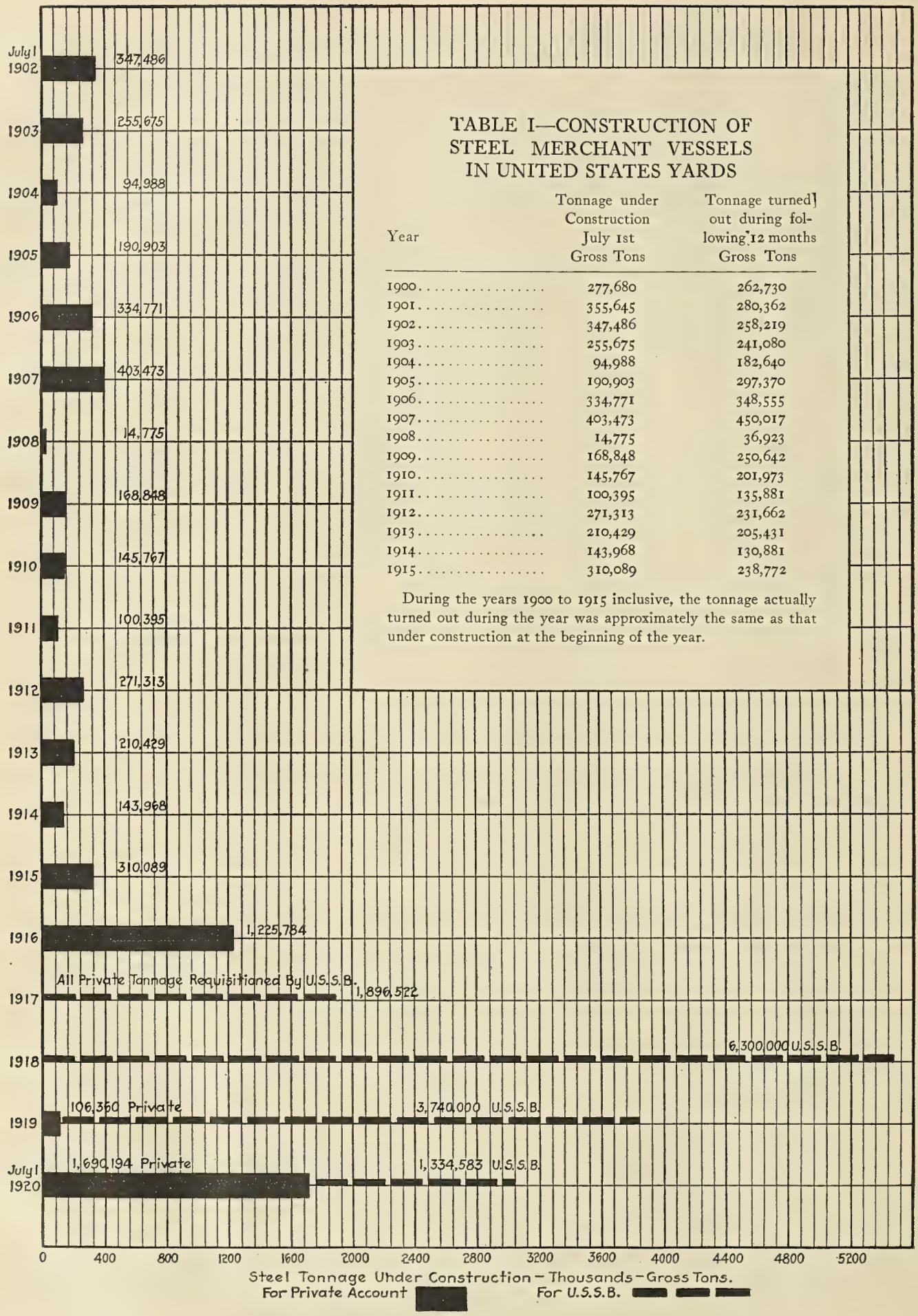


TABLE I—CONSTRUCTION OF STEEL MERCHANT VESSELS IN UNITED STATES YARDS

Year	Tonnage under Construction July 1st Gross Tons	Tonnage turned out during following 12 months Gross Tons
1900	277,680	262,730
1901	355,645	280,362
1902	347,486	258,219
1903	255,675	241,080
1904	94,988	182,640
1905	190,903	297,370
1906	334,771	348,555
1907	403,473	450,017
1908	14,775	36,923
1909	168,848	250,642
1910	145,767	201,973
1911	100,395	135,881
1912	271,313	231,662
1913	210,429	205,431
1914	143,968	130,881
1915	310,089	238,772

During the years 1900 to 1915 inclusive, the tonnage actually turned out during the year was approximately the same as that under construction at the beginning of the year.

Fig. 1.—Steel Merchant Tonnage Under Construction in United States Shipyards

American Shipbuilding—Present and Future

Output of Merchant Tonnage Has Increased Six-Fold—Repair Yards Active—Large Naval Programme Under Way

THE tremendous shipbuilding programme initiated in the United States as a war-time emergency measure is now practically completed. At the height of this building programme the United States reached a production in ship tonnage far greater than any other country has ever attained, or ever will attain.

But in order to take advantage of the shipbuilding facilities which could be made most quickly available, the emergency programme necessarily contained a large percentage of wooden ships and of small steel cargo vessels. While the construction of such ships was fully justified by the emergency, their relatively small commercial value will eliminate them from any construction under normal conditions. Moreover, even in the construction of large steel vessels of the best type, yards were utilized and methods were employed which would never have been used for building ships on a strictly commercial basis.

In determining today the relative position of shipbuilding as a sound, healthy industry, it is essential, therefore, to disregard largely the war-time programme.

Merchant Marine Vital to National Prosperity

Our national prosperity during the past few years has been due largely to our foreign trade and our continued prosperity depends ultimately on foreign business. To maintain our connections with foreign buyers, so essential to our national prosperity, a large and efficient merchant marine with ample facilities for the building and repairing of vessels is absolutely necessary. Both the shipbuilding and shipping industries have taken a permanent place in America and will be maintained.

Ships Building for Private Account

The sound growth of the shipbuilding industry is dependent upon construction for private interests, inasmuch as such ships are built to fill the normal needs of a particular trade. In the spring of 1919 shipyards were again permitted to accept orders for private account, and by July 1, 1919, contracts had been let for over 100,000 gross tons of steel ships. By July 1, 1920, the tonnage under construction or contracted for, for private account, had increased to approximately 1,700,000 gross tons.

Only by comparison with pre-war construction for private interests can this volume of shipbuilding be appreciated. Fig. 1 shows graphically the tremendous increase in private construction during the past few years.

Shipbuilding a Leading Industry

A comparison of shipbuilding with our other national industries gives an idea of its enormous expansion. In 1914 the total value of the output of the industries of iron and steel and their products was $3,223,144,000, of which shipbuilding was approximately 2¾ percent. The present estimated value of the annual output of the iron and steel industries is $6,500,000,000, of which shipbuilding is approximately 15 percent.

In 1914 shipbuilding, with a total value of output of $88,682,000, ranked fifty-eighth among the industries of the United States. The construction now under way places shipbuilding in about fifteenth position, surpassing such industries as leather, furniture, chemicals, paper and wood pulp, agricultural implements, silk and sugar.

Output of Shipyards Increased Six-Fold

The steel merchant tonnage now under construction for private account (approximately 1,500,000 gross tons) is over six times the average pre-war output of steel merchant vessels (235,000 gross tons annually), and is approximately three and one-half times our best annual output prior to the war (450,017 gross tons of steel ships in 1908).

Over 2,000,000 Tons Now Under Construction

On September 1, 1920, there were under construction 2,463,314 gross tons of steel merchant vessels. Of these, 1,438,498 gross tons were for private account and 1,024,816 gross tons were for the United States Shipping Board. On September 15, 1920, there were under construction for private account steel vessels aggregating 1,449,859 gross tons. This was practically the same as the private account tonnage under construction on July 1, 1920, new orders having replaced the tonnage delivered. This indicates that shipbuilding should continue for the next year or two at a minimum of approximately 1,500,000 gross tons annually.

Statistics on shipbuilding for the years 1900 to 1915 inclusive show that the total tonnage of steel merchant vessels under construction at the beginning of each fiscal year was practically the same as that turned out during that year. Inasmuch as our shipyards are again working under normal conditions, we may expect to deliver the tonnage now building within the next twelve months, and this figure, rather than the tonnage built during the past year, may be used in estimating production during 1921.

Increased Naval Construction

Another important phase of the shipbuilding industry is the current construction for the United States Navy and other Government departments. At present the vessels being built for the Navy aggregate well over 1,000,000 tons displacement, a large percentage of which are being constructed in private yards. Present indications are that this programme will continue for the next two or three years.

Growth of the Merchant Marine

The tonnage of our merchant marine has more than doubled during the past six years, and our present tonnage is over 16,000,000 gross tons, slightly less than one-third the total world tonnage. The tonnage now under construction will bring this total up to approximately 19,000,000 gross tons by July 1, 1921. Our foreign commerce has also increased enormously, and the percentage of our foreign commerce carried in American ships has increased in even greater proportion. In 1914 the proportion of American tonnage to the total tonnage entering and clearing United States ports was 26 percent, while during the first six months of 1920 this had jumped to 60 percent (see Fig. 2).

Ship Construction Required for Replacement

That a minimum annual output of 1,500,000 gross tons of steel merchant vessels is a conservative estimate is borne out by the following: By July 1, 1921, our merchant marine will aggregate approximately 19,000,000 gross tons. Assuming

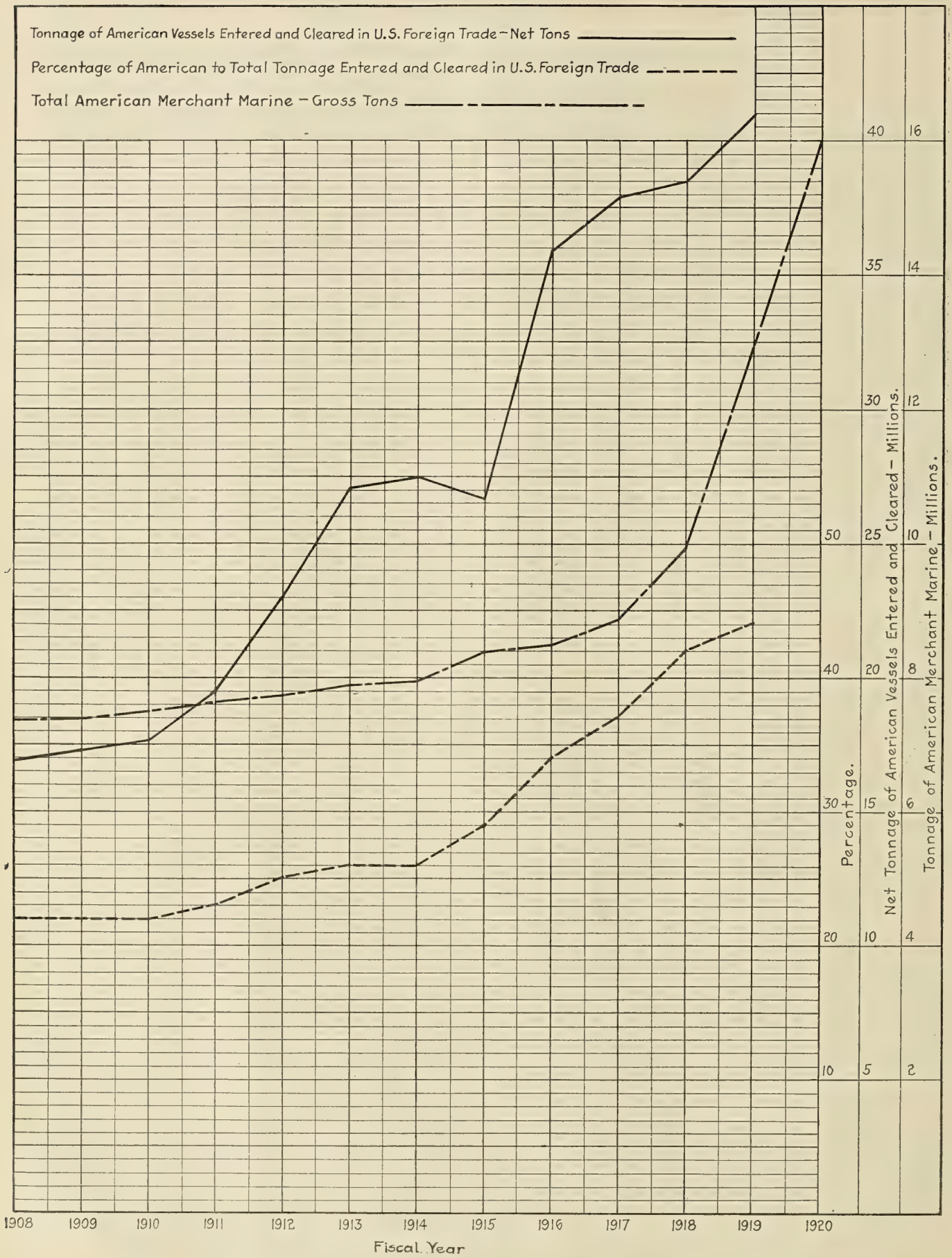


Fig. 2.—Expansion of the American Merchant Marine

the average life of a ship to be twenty years, there will be required annually for the *upkeep only* of our merchant fleet 5 percent of this tonnage, or approximately *950,000 gross tons.* Actual replacements will undoubtedly be much larger, inasmuch as a large part of our present merchant marine is composed of wooden ships.

Repair Yards Active

The rapid growth of our merchant fleet has brought a large volume of repair work to our ship repair plants. In a few years, when the new ships of our present merchant marine begin to show signs of wear, our present repair facilities will be inadequate for this work, and we can then look for considerable expansion in the ship repair industry.

The Jones Bill

That it is the firm intention of the American people to maintain the advantage in shipbuilding and ship operating gained during the past few years is evidenced by recent legislative acts, the principal one being the Jones Bill. Among its provisions are the establishment of steamship lines by the United States Shipping Board, the sale of Shipping Board ships to private owners on easy terms, the establishment of a fund of $25,000,000 annually for five years to be loaned for the construction of new vessels in United States yards, and the remission of excess profits taxes to the ship operating companies, provided they are used for the construction of new vessels in United States yards. Since the passage of this bill in June, 1920, contracts have been let for approximately 250,000 gross tons of steel ships to be built under its provisions.

Continued legislation favorable to shipping is assured by the attitude of the incoming administration.

Prosperity Assured During 1921 and Later

The orders for merchant vessels already placed despite present high costs assure the prosperity of the shipbuilding industry during 1921.

All present indications are that the American shipbuilding industry will enjoy still greater prosperity in future years. Reconstruction in Europe has hardly begun and European manufacturers are not able to meet domestic demands, to say nothing of foreign orders. When foreign exchange returns to a normal basis the resultant demand for American goods throughout the world will lead to a vast increase in our foreign trade and an increased demand for ships. Still more ships will be needed to care for future foreign trade.

A considerable amount of new construction for foreign account can also be expected as soon as exchange rates become normal. Plans for a number of these ships have been drawn in this country. At present the greater part of our merchant fleet is composed of new vessels, some of which were built when *quantity* of tonnage was more urgent than *quality.* As these ships grow older an increase in repairs and more frequent replacements will be necessary in order to keep our merchant marine in shape to meet foreign competition.

TABLE I.—MERCHANT VESSELS BUILT IN THE UNITED STATES IN 1920

Shipyard	Number of Ships	Total Gross Tonnage	Total Horsepower
American Bridge Company	45	35,000	.....
American International Shipbuilding Corporation	46	399,950	115,000
American Shipbuilding Company	63	255,900	75,600
Ames Shipbuilding Company	2	11,732	6,000
Baltimore Dry Docks & Shipbuilding Company	10	65,780	23,950
Bath Iron Works, Inc	1	6,250	2,400
A. Bentley & Sons Company	2	7,500	2,800
Bethlehem Shipbuilding Corporation, Ltd.			
Fore River Plant	3	36,740	8,900
Harlan Plant	9	65,500	20,800
Moore Plant	7	14,270	3,880
Sparrows Plant	7	75,840	20,400
Union Plant (Potrero)	4	45,600	11,700
Union Plant (Alameda)	13	131,400	36,400
Bowker Shipyard	1	1,250	.....
Chance Marine Construction Company	3	492	1,350
Chickasaw Shipbuilding & Car Company	5	30,265	16,600
Francis Cobb Shipbuilding Company	1	2,500	.....
Consolidated Shipbuilding Corporation	1	310	200
Wm. Cramp & Sons Ship & Engine Building Company*	5	29,344	14,300
Crosby Navigation Company	1	1,000	.....
Cumberland Shipbuilding Company	1	1,138	.....
Oscar Daniels Company	6	57,000	16,800
Datchel-Carter Shipbuilding Company	2	400	900
M. M. Davis and Son, Inc	10	10,000	.....
Doullut & Williams Shipbuilding Company	6	39,786	16,800
Downey Shipbuilding Corporation	2	8,438	5,000
Dravo Contracting Company (Engineering Works Department)	38	14,180	.....
Dubuque Boat & Boiler Works*	5	9,060	100
East Coast Ship Company	2	2,096	.....
Federal Shipbuilding Company	18	78,750	32,900
W. & A. Fletcher Company	(17 sets Parsons compound turbines total horsepower 49,500)		
Frye Flynn Company	1	1,156	.....
George A. Fuller Company	8	52,008	22,400
Globe Shipbuilding Company	4	10,000	4,800
Great Lakes Engineering Works	6	16,044	8,700
Greenport Basin & Construction Company	1	73	50
Groton Iron Works	3	18,648	8,400
Heldenfels Brothers	2	8,000	.....
Henderson Shipbuilding Company, Inc	4	1,600	
H. R. James Company	1	92	125
Job Shipyard Corporation	2	1,035	.....
Johnson Iron Works, Dry Dock and Shipbuilding Company, Inc	7	1,741	302
Johnson Shipyards Corporation	11	13,250	.....
Kyle & Purdy, Inc	5	3,500	4,500
Leatham & Smith Towing & Wrecking Company	1	85	450
LeParmentier Shipbuilding Corporation	5	20,000	7,000
Long Beach Shipbuilding Company	6	37,200	12,150
Los Angeles Shipbuilding & Dry Dock Company	12	68,760	45,600
McCoy Bros. Incorporated	3	204	320
MacDonald Engineering Company	2	.....	.....
Manitowoc Shipbuilding Company	9	22,831	14,750
Mathis Shipbuilding Company	3	600	2,400
Merchant Shipbuilding Corporation			
Chester Yard	11	65,780	27,500
Harriman Yard	16	92,160	40,000
Merrill-Stevens Shipbuilding Corporation	3	18,000	6,000
Moore Shipbuilding Company	10	68,300	29,600
Nashville Bridge Company*	5	2,500	.....
Newburgh Shipyards, Inc	5	27,000	14,600

TABLE I.—MERCHANT VESSELS BUILT IN THE UNITED STATES IN 1920—Continued.

Shipyard	Number of Ships	Total Gross Tonnage	Total Horsepower
New York Harbor Dry Dock Corporation	6	11,560	7,200
New York Shipbuilding Corporation*	13	148,800	113,450
Newport Shipbuilding Company	9	5,400	5,400
Newport News Shipbuilding & Dry Dock Company	5	47,284	23,400
Norfolk Shipbuilding & Dry Dock Corporation	1	.....	.....
Pacific Coast Shipbuilding Company	4	37,600	12,000
Pacific Marine & Construction Company	2	12,972	5,600
Pensacola Shipbuilding Company	10	54,000	33,000
Percy & Small, Inc	1	1,103	.....
Pusey & Jones Company	12	56,840	26,450
James Rees & Sons Company	2	310	324
G. D. Ryan & Son	1	370	.....
Saginaw Shipbuilding Company	6	25,500	9,000
Schaw-Batcher Shipbuilding Company	6	52,800	16,800
South Western Shipbuilding Company	8	46,054	20,600
Standard Shipbuilding Corporation	5	18,874	10,500
St. Helens' Shipbuilding Company	1	2,500	1,400
St. Helena Shipbuilding Company	1	2,500	1,400
G. M. Standifer Construction Corporation	6	487,000	153,000
Staten Island Shipbuilding Company*	9	4,227	1,000
Stockton Yards, Inc	2	2,600	.....
A. D. Storey Shipyard	4	900	.....
Submarine Boat Corporation	42	148,890	90,000
Sun Shipbuilding Company	14	92,800	42,000
Tank Ship Building Corporation*	8	5,600	.....
Tebo Yacht Basin Company	3	6,950	3,650
Texas Steamship Company	5	30,315	13,000
Todd Dry Dock & Construction Corporation*	8	38,400	20,000
Toledo Shipbuilding Company	7	17,913	10,500
E. James Tull	2	600	.....
Union Construction Company	6	32,825	15,300
Union Shipbuilding Company	5	32,200	10,600
Virginia Shipbuilding Corporation	5	30,300	14,000
Chas Ward Engineering Works	1	757	1,800
Western Pipe & Steel Company	8	70,400	22,400

*Yards also engaged on Naval Construction (Table III).

TABLE II.—MERCHANT VESSELS NOW UNDER CONSTRUCTION IN THE UNITED STATES

Shipyard	Number of Ships	Total Gross Tonnage	Total Horsepower
American Bridge Company	62	26,300	.....
American International Shipbuilding Corporation	7	56,000	17,500
Anchor Shipbuilding Company	1	.....	300
Baltimore Dry Docks & Shipbuilding Company	6	42,002	13,250
Bath Iron Works, Inc	1	6,250	2,400
Bethlehem Shipbuilding Corporation			
Fore River Plant	7	99,060	24,800
Harlan Plant	3	24,400	7,800
Moore Plant	2	1,500	1,400
Sparrows Point	13	170,020	91,500
Union Plant (Potrero)	1	10,100	2,800
Union Plant (Alameda)	10	118,000	28,890
Cambridge Manufacturing Company	4	800	.....
Chickasaw Shipbuilding & Car Company	8	45,488	24,800
Francis Cobb Shipbuilding Company	1	2,500	.....
Consolidated Shipbuilding Corporation	3	2,575	1,800
William Cramp & Sons Ship & Engine Building Company	1	3,350	3,600
Oscar Daniels Company	4	43,000	11,200
M. M. Davis & Son, Inc	2	1,700	.....
Doullut & Williams Shipbuilding Company	2	13,202	5,600
Downey Shipbuilding Corporation	2	4,719	3,000
Dravo Contracting Company (Engineering Works Department)	24	3,270	500
Dubuque Boat & Boiler Works	2	2,500	250
Federal Shipbuilding Company	16	74,750	25,800
Frye-Flynn Company	1	1,100	.....
Great Lakes Engineering Works	1	1,400	3,000
Groton Iron Works	1	900	700
Job Shipyard Corporation	1	315	.....
Johnson Iron Works, Dry Dock and Shipbuilding Company, Inc	9	2,977	102
Johnson Shipyards Corporation	4	4,352	980
Kelley-Spear Company	2	3,250	.....
Kyle Purdy, Inc	4	2,800	1,800
Lanteri's Shipyard	2	.....	.....
Leatham & Smith Towing & Wrecking Company	1	85	400
Le Parmentier Shipbuilding Corporation	2	8,000	2,800
Long Beach Shipbuilding Company	1	8,800	2,800
Los Angeles Shipbuilding & Dry Dock Company	5	37,300	19,000
S. C. McLouth Shipbuilding Company	1	200	350
Merchant Shipbuilding Corporation (Chester Yard)	8	41,500	.....
Moore Shipbuilding Company	9	67,300	33,400
Nashville Bridge Company	7	3,000	300
Newburgh Shipyards, Inc	4	11,500	12,000
New Jersey Dry Dock & Shipbuilding Company	4	3,600	2,200
New York Harbor Dry Dock Corporation	1	3,285	1,600
New York Shipbuilding Corporation*	13	121,318	86,900
Newport News Shipbuilding & Dry Dock Company*	5	62,100	26,600
Newport Shipbuilding Company	10	14,875	7,800
Northwest Bridge & Iron Works	7	56,000	22,400
Pacific Coast Shipbuilding Company	4	29,400	9,500
James Rees & Sons Company	2	1,192	1,600
G. D. Ryan & Son	3	990	100
Southwestern Shipbuilding Company	6	38,797	17,200
Standard Shipbuilding Corporation	2	11,228	5,700
Standifer, G. M., Construction Corporation	4	48,000	12,000
Staten Island Shipbuilding Company	10	13,356	4,600
Stockton Yard, Inc	1	1,300	.....
A. D. Story Shipyard	3	700	.....
Submarine Boat Corporation	5	17,725	7,500
Tank Shipbuilding Corporation	2	850	900
Tebo Yacht Basin Company	1	1,450	.....
Texas Steamship Company	8	19,304	6,000
Todd Dry Dock & Construction Corporation*	1	4,000	2,400
Union Construction Company	5	29,319	13,400
Union Shipbuilding Company	4	26,800	15,000
Virginia Shipbuilding Corporation	1	6,060	2,800
Chas. Ward Engineering Works	3	.....	.....

*Yard also engaged on Naval Construction (Table IV)

TABLE III.—NAVAL VESSELS BUILT IN AMERICAN PRIVATE SHIPYARDS IN 1920

Shipyard	Number of Ships	Total Tons Displacement	Total Horsepower
Bath Iron Works, Inc	3	3,630	82,500
Bethlehem Shipbuilding Corporation			
Fore River Plant	8	9,191	144,200
Union Plant (Potrero)	12	13,878	272,400
Union Plant (Risdon)	12	12,700	324,000
William Cramp & Sons Ship & Engine Building Company	15	18,450	420,000
Dubuque Boat & Boiler Works	5	.....	.....
Lake Torpedo Boat Company	2	1,675	2,800
George Lawley & Sons Corporation	1	850	.....
Nashville Bridge Company	31	6,000	.....
New York Shipbuilding Corporation	10	13,500	270,000
Newport News Shipbuilding & Dry Dock Company	5	.....	.....
Staten Island Shipbuilding Company	6	6,000	12,000
Tank Ship Building Corporation	5	4,250	1,000
Todd Dry Dock & Construction Corporation	1	1,125	2,100

TABLE IV.—NAVAL VESSELS NOW UNDER CONSTRUCTION IN AMERICAN PRIVATE SHIPYARDS

Shipyard	Number of Ships	Total Tons Displacement	Total Horsepower
Bethlehem Shipbuilding Corporation			
Fore River Plant	23	108,784	445,600
Union Plant (Potrero)	22	23,240	336,000
Union Plant (Risdon)	7	8,575	189,000
Wm. Cramp & Sons Ship & Engine Building Company	7	37,960	506,000
Gulfport Shipbuilding Company	6	.....	725
Lake Torpedo Boat Company	7	6,625	10,200
New York Shipbuilding Corporation	6	112,750	315,600
Newport News Shipbuilding & Dry Dock Company	4	.....	.....
Todd Dry Dock & Construction Corporation	3	21,000	270,000
Union Construction Company	5	7,364	11,400

TABLE V.—STEEL VESSELS UNDER CONSTRUCTION IN AMERICAN SHIPYARDS, DECEMBER 1, 1920

Builders	Owners	Type	Gross Tonnage	No.	Total Tonnage
American Bridge Company	Portland Cement Company	Barge	300	3	900
American Bridge Company	Bell Iron Works	Barge	600	32	19,200
American Bridge Company	Standard Oil Company	Barge	500	4	2,000
American Bridge Company	U. S. Railroad Administration	Barge	900	25	22,500
American Bridge Company	U. S. War Department	Barge	350	6	2,100
American Bridge Company	Carnegie Steel Company	Barge	575	25	14,375
American Car & Foundry Company	Philadelphia & Reading Railroad	Barge	500	1	500
American Car & Foundry Company	Atlantic Refining Company	Oil Barge	350	1	350
Baltimore Dry Docks and Shipbuilding Company	.....	Tanker	6,000	1	6,000
Baltimore Dry Docks and Shipbuilding Company	.....	Freighter	4,000	2	8,000
Baltimore Dry Docks and Shipbuilding Company	Builders	Tanker	6,000	2	12,000
Baltimore Dry Docks and Shipbuilding Company	Builders	Freighter	4,311	2	8,622
Bath Iron Works	Crowell & Thurlow	Freighter	6,250	1	6,250
Bath Iron Works	Crowell & Thurlow	Freighter	6,253	1	6,253
Bethlehem Shipbuilding Company					
Fore River	Atlantic Gulf & West Indies Company	Tanker	7,800	1	7,800
Fore River	Sinclair Navigation Company	Tanker	6,600	2	13,200
Fore River	Standard Transportation Company	Tanker	7,800	1	7,800
Fore River	Standard Transportation Company	Tanker	7,794	2	15,588
Harlan Plant	Sinclair Navigation Company	Tanker	7,077	2	14,154
Harlan Plant	Sinclair Navigation Company	Tanker	4,500	2	9,000
Moore Plant	Standard Transportation Company	Tanker	1,200	1	1,200
Moore Plant	Western Maryland Railroad	Car Floats	1,200	2	2,400
Sparrows Point	Ore Steamship Company	Tanker	13,500	1	13,500
Sparrows Point	Lux Navigation Company	Tanker	5,845	2	11,690
Sparrows Point	International Petroleum Company	Tanker	13,500	1	13,500
Sparrows Point	Atlantic Gulf & West Indies Company	Tanker	7,800	2	15,600
Sparrows Point	Standard Transportation Company	Tanker	6,900	1	6,900
Sparrows Point	Standard Transportation Company	Tanker	7,500	1	7,500
San Francisco	General Petroleum Corporation	Tanker	7,060	1	7,060
San Francisco	Pan American Petroleum & Transportation Company	Tanker	7,060	1	7,060
San Francisco	Standard Oil Company of California	Tanker	7,060	1	7,060
San Francisco	Standard Oil Company of California	Tanker	8,650	1	8,650
San Francisco	Standard Transportation Company	Tanker	7,060	1	7,060
San Francisco	Associated Oil Company	Tanker	7,100	1	7,100
San Francisco	Standard Oil Company of California	Tanker	10,000	3	30,000
Brunswick Marine Corporation	R. L. Smith	Freighter	960	1	960
Wm. Cramp & Sons Ship and Engine Building Company	Florida East Coast Railway	Freighter	2,406	1	2,406
Wm. Cramp & Sons Ship and Engine Building Company	Peninsula & Ocean Steamship Company	Pass.& Cgo.	2,000	1	2,000
Oscar Daniels Company	Standard Oil Company of New Jersey	Tanker	7,800	1	7,800
Oscar Daniels Company	Builders	Tug	350	1	350
Downey Shipbuilding Company	Southern Pacific Company	Freighter	3,850	3	11,550
Downey Shipbuilding Company	Mexican Petroleum Company	Oil Carrier	550	1	550
Dravo Contracting and Construction Company	United States Railroad Administration	Barge	273	4	1,092
Dravo Contracting and Construction Company	United States Railroad Administration	Barge	1,500	2	3,000
Dravo Contracting and Construction Company	Keystone Sand & Supply Co	Barge	200	4	800
John Eichleay Company	United States Engineers	Towboat	200	1	200
John Eichleay Company	Western Kentucky Coal Company	Towboat	200	1	200
Federal Shipbuilding Company	War Department	Barge	350	(See American Bridge Co.)	
Kearny, N. J.	Standard Oil Company	Tanker	10,000	5	50,000
Kearny, N. J.	Mexican Petroleum Company	Barge	450	4	1,800
Kearny, N. J.	United States Steel Products	Freighter	6,000	3	18,000
Chickasaw, Ala.	Builders	Freighter	6,869	1	6,869
Chichasaw, Ala.	United States Steel Products	Freighter	6,000	9	54,000
Geo. A. Fuller Company	Builders	Freighter	6,121	4	24,484
Globe Shipbuilding Company	Builders	Freighter	5,700	2	11,400
Great Lakes Engineering Works	Horace E. Dodge	St. Yacht	600	1	600
Johnson Iron Works	Builders	Barge.	200	3	600
Kyle & Purdy	International Petroleum Company	Tug	100	1	100
Kyle & Purdy	Atlantic Gulf Oil	Tug	100	1	100
Kyle & Purdy	East Coast Fisheries	Trawler	670	2	1,340
Kyle & Purdy	Max Fleischman	Yacht	250	1	250
Lawley & Son, Geo.	Edgar Farnum	Aux. Yacht	350	1	350

TABLE V.—VESSELS UNDER CONSTRUCTION IN AMERICAN SHIPYARDS, DECEMBER 1, 1920. (CONTINUED).

Builders	Owners	Type	Gross Tonnage	No.	Total Tonnage
Manitowoc Shipbuilding Company	Atlantic Fruit Company	Fruit Str.	1,600	1	1,600
Manitowoc Shipbuilding Company	Builders	Freighter	2,712	3	8,136
McDougall-Duluth Company	Julius Barnes	Freighter.	1,580	1	1,580
Merchant Shipbuilding Corporation	Union Oil Company (Del.)	Tanker	6,250	2	12,500
Merchant Shipbuilding Corporation	American Hawaiian Steamship Company	Freighter	7,800	2	15,600
Merchant Shipbuilding Corporation	Shawmut Steamship Company	Freighter	7,300	2	14,600
Merchant Shipbuilding Corporation	Cochran Harper Company	Tanker	6,250	2	12,500
Merrill-Stevens	Arellano-y-Mendoza	.....	300	1	300
Moore Shipbuilding Company	Matson Navigation Company	Freighter	9,500	2	19,000
Moore Shipbuilding Company	Standard Oil Company of California	Tanker	3,250	1	3,250
Moore Shipbuilding Company	Standard Oil Company of California	Tanker	7,000	3	21,000
Moore Shipbuilding Company	Vacuum Oil Company	Tanker	7,000	1	7,000
Moore Shipbuilding Company	Southern Pacific Company	Tanker	9,600	1	9,600
Moore Shipbuilding Company	Vacuum Oil Company	Tanker	7,089	1	7,089
Newburgh Shipyards, Inc	Cuyamel Fruit Company	Freighter	3,000	2	6,000
Newburgh Shipyards, Inc	Union Sulphur Company	Freighter	4,700	1	4,700
New Jersey Dry Dock Company	East Coast Fisheries	Trawler	355	2	710
Newport News Shipbuilding & Dry Dock Company	Atlantic, Gulf & West Indies Company	Tanker	10,600	2	21,200
Newport News Shipbuilding & Dry Dock Company	Standard Oil Company of New Jersey	Tanker	13,500	2	27,000
New York Harbor Dry Dock Corporation	.....	.....	3,285	2	6,570
New York Shipbuilding Corporation	Pacific Mail Steamship Company	Tanker	6,800	1	6,800
New York Shipbuilding Corporation	United Fruit Company	Tanker	6,800	1	6,800
New York Shipbuilding Corporation	Standard Transportation Company	Tanker	7,794	4	31,176
New York Shipbuilding Corporation	Munson Steamship Company	Freighter	6,000	1	6,000
New York Shipbuilding Corporation	Builders	Tanker	6,800	2	13,600
Northwest Bridge & Iron Company	Swiftsure Oil Transportation Company	Tanker	9,000	7	63,000
Pacific Coast Shipbuilding Company	Associated Oil Company	Motor Tk.	188	1	188
Pacific Coast Shipbuilding Company	Associated Oil Company	Tanker	1,000	1	1,000
Pensacola Shipbuilding Company	Morris Adler	Tug	300	1	300
Pusey & Jones Company	Philadelphia & Reading R. R.	Pass. Ferry	773	2	1,546
Rice Bros	Atlantic Coast Fisheries	Trawler	400	4	1,600
Southwest Shipbuilding Company	Luckenbach Steamship Lines	Freighter	6,100	1	6,100
Southwest Shipbuilding Company	Union Oil Company of California	Tanker	8,650	2	17,300
Southwest Shipbuilding Company	Anglo Saxon Petroleum Company	Tanker	5,600	3	16,800
Southwest Shipbuilding Company	Union Oil Company of California	Tanker	4,788	1	4,788
Spedden Shipbuilding Company	Standard Oil Company of N. J	Barge	995	1	995
Spedden Shipbuilding Company	Builders	Tug	325	1	325
Standard Shipbuilding Corporation	Cuyamel Fruit Company	Fruit Str.	900	2	1,800
Standard Shipbuilding Corporation	Eagle Oil Transportation Company	Tanker	5,600	4	22,400
G. M. Standifer Construction Company	Standard Oil Company of New Jersey	Tanker	8,250	3	24,750
G. M. Standifer Construction Company	Imperial Oil, Ltd	Tanker	8,250	2	16,500
Staten Island Shipbuilding Company	Galena Signal Oil Company	Tanker	2,500	1	2,500
Staten Island Shipbuilding Company	American Sugar Refining Company	Tanker	4,200	1	4,200
Staten Island Shipbuilding Company	Standard Oil Company of New York	Motor Barge	450	1	450
Staten Island Shipbuilding Company	Standard Oil Company of New York	Barge	1,200	3	3,600
Staten Island Shipbuilding Company	Standard Oil Company of New York	Barge.	420	5	2,100
Submarine Boat Corporation	Builders	Freighter.	3,545	7	24,815
Sun Shipbuilding Company	Sun Oil Company	Tanker	8,533	3	25,599
Sun Shipbuilding Company	Atlantic Gulf & West Indies Company	Tanker	6,800	1	6,800
Sun Shipbuilding Company	Atlantic Gulf & West Indies Company	Tanker	9,000	4	36,000
Sun Shipbuilding Company	Atlantic, Gulf & West Indies Company	Tanker	6,700	1	6,700
Sun Shipbuilding Company	Pan American Petroleum & Transportation Company	Tanker	6,700	2	13,400
Sun Shipbuilding Company	Sinclair Navigation Company	Tanker	6,700	2	13,400
Sun Shipbuilding Company	Standard Oil Company of New Jersey	Tanker	6,800	2	13,600
Sun Shipbuilding Company	Union Oil Company	Tanker	9,000	2	18,000
Sun Shipbuilding Company	Societe Anonyme d'Oriente d'Industre	Tanker	6,800	1	6,800
Sun Shipbuilding Company	Tidewater Oil Company	Tanker	6,800	1	6,800
Sun Shipbuilding Company	Norwegian American Line	Tanker	6,800	1	6,800
Tank Shipbuilding Corporation	Panuco Exploration Company	.....	750	1	750
Tank Shipbuilding Corporation	Beacon Oil Company	.....	500	1	500
Tank Shipbuilding Corporation	Sunset Fuel Oil Company	Oil Barge	1,250	1	1,250
Terry Shipbuilding Corporation	United States Mexican Oil Transportation Company	Tanker	5,190	1	5,190
Texas Company	Builders	Tanker	6,700	4	26,800
Texas Company	Builders	Mot. Tk.	3,500	1	3,500
Texas Company	Builders	Barge	750	3	2,250
Todd Dry Dock & Construction Company	Alaska Steamship Company	Freighter	3,900	1	3,900
Union Shipbuilding Company	Builders	Freighter	7,150	4	28,600
Union Shipbuilding Company	Gulf Refining Company	Tanker	6,700	2	13,400
Union Construction Company	General Petroleum Company	Tanker	7,000	1	7,000
Union Construction Company	Standard Oil Company of California	Tanker	7,000	1	7,000
Union Construction Company	Standard Oil Company of California	Motor Tk.	1,650	1	1,650
Union Construction Company	Shell Oil Company	Tanker	7,000	1	7,000
Union Construction Company	Anglo Saxon Petroleum Company	Tanker	5,600	3	16,800
Virginia Shipbuilding Corporation	United States Steamship Compan	Freighter	6,060	3	18,180
				341	1,300,710

TABLE VI.—STEEL VESSELS UNDER CONSTRUCTION FOR THE UNITED STATES SHIPPING BOARD DECEMBER, 20, 1920.

Builders	Type	D. W. Tonnage	No.	Total D. W. Tonnage
American International Shipbuilding Corporation	Transport	8,000	5	40,000
Baltimore Dry Docks & Shipbuilding Company	Tanker	10,300	1	10,300
Baltimore Dry Docks & Shipbuilding Company	Tanker	6,000	1	6,000
Baltimore Dry Docks & Shipbuilding Company	Tanker	10,200	4	40,800
Bethlehem Shipbuilding Company:				
Harlan Plant	Cargo	7,400	1	7,400
Sparrows Point Plant	Cargo & Pas.	13,000	5	65,000
San Francisco Plant	Tanker	10,100	3	30,300
San Francisco Plant	Cargo	11,800	1	11,800
Wm. Cramp & Sons Ship & Engine Building Company	Cargo	9,400	1	9,400
Oscar Daniels Company	Cargo	9,500	3	28,500
Doullut & Williams Shipbuilding Company	Cargo	9,600	7	67,200
Groton Iron Works	Cargo	9,400	1	9,400
Hanlon Dry Dock & Shipbuilding Company	Cargo	5,300	1	5,300
Long Beach Shipbuilding Company	Cargo	8,800	1	8,800
Los Angeles Shipbuilding & Dry Dock Company	Cargo	8,800	3	26,400
Los Angeles Shipbuilding & Dry Dock Company	Cargo	11,000	5	55,000
Merchant Shipbuilding Corporation:				
Harriman Plant	Cargo	9,000	5	45,000
Moore Shipbuilding Company	Cargo	9,400	1	9,400
Moore Shipbuilding Company	Tanker	10,000	3	30,000
Newburgh Shipyards, Inc	Cargo	9,000	1	9,000
Newport News Shipbuilding & Dry Dock Company	Cargo	13,000	2	26,000
New York Shipbuilding Corporation	Pas. & Cargo	13,000	13	169,000
Pacific Coast Shipbuilding Comapny	Cargo	9,400	3	28,200
Pusey & Jones Company (Gloucester yard)	Diesel Cargo.	12,500	1	12,500
Saginaw Shipbuilding Company	Cargo	4,050	1	4,050
Virginia Shipbuilding Company	Cargo	9,400	1	9,400
Kiangnan Dock & Engineering Works (Shanghai, China)	Cargo	10,000	4	40,000
			78	814,150

Brace Up, America! Don't Give Up the Ships!!

We Have the Ships, the Men, the Money, the Banking and Insurance Facilities: Why Not Make Shipping Pay?

BY C. A. MC ALLISTER

THESE be "parlous" days we are passing through in merchant marine matters. What with head lines in the daily papers featuring up all kinds of graft and irregularities in connection with our shipping efforts; with freight rates gone to smash; with few contracts being made for new ships, and a general air of depression engulfing us wherever we turn, times, indeed, seem bad and the future dark and dreary.

As a youth the writer was taught that under similar circumstances, which must come to all at one time or another, it is very consoling to consider two things, the first of which is how much worse it could be, and the next, how does it affect the other fellow? Therefore the object of this brief article will be to show that somewhere the sun is shining and that things maritime are not so bad as they seem.

Wrong Impressions from Shipping Board Investigation

Let us first look into this investigation which has so shocked the public. Admittedly it came at a very inopportune time, as the daily press just finished up with the details of a presidential election and just prior to the many news features incident to the opening of Congress, was in a peculiarly receptive condition to magnify most trivial and ordinary details of the investigation, which at any other time might have drawn a small paragraph instead of flaming headlines. Mr. Average Citizen, as we all know, only reads headlines concerning everything except the small portion of a daily devoted to some particular subject in which he may be specially interested. Hence, at this writing, in the public eye for a fleeting moment or so, everyone connected with shipbuilding, ship operating, etc., must be a low-down grafter. How unfortunate this impression is, and also how untrue! While the writer would be the last one to condone anything crooked in the expenditure of public money and hopes fervently that everyone who has maliciously misappropriated any Shipping Board money may promptly be jailed, there are certain extenuating circumstances which must be taken into consideration in a just analysis of the Board's activities since its formation.

The first of these may be expressed by the simile of the man who neglected during a long period of fine weather to put a new roof on his barn, and then when the storm broke rushed wildly to make good his neglect by putting on the roof during the worst part of the storm in order to protect the goods he had stored therein. Naturally the new roof cost a vast sum of money and many of the contents of the barn were spoiled or wasted in the process. Almost exactly a similar condition existed with our merchant marine; we had neglected all warnings and advice for a fine weather period of over half a century, and then tried to make good that long period of neglect by constructing hundreds of the essential ships during two or three years of the greatest storm that ever struck this mundane sphere. The result has been waste and profligacy, as must inevitably have occurred. So let us be frank with ourselves and liken the early efforts of the Shipping Board to that far-famed orchestra in a mining town theater which gave rise to the story of how their lives were saved from the frenzy of the red-shirted miners by the imprecations "Don't shoot the musicians, boys, they are doing the best they can." In other words, again to resort to musical terms, the American people have had to pay the fiddler for their own neglect in the past. And it was not alone in the Shipping Board's activities that we have had to pay the fiddler—just look at the billions we sank in aeroplanes, heavy guns, improvised submarine patrol boats, etc., as the result of our national lack of policy and putting on the roof after the storm breaks. Let us hope that after all these investigations have ceased the thinking public will, in retrospect, put the blame for the greater part of all these shortcomings where it rightfully belongs—on ourselves.

Petty Graft

Great agonizing has been indulged in because, forsooth, some stewards, chief engineers and captains have secured certain commissions or rake-offs on goods which they have purchased to operate Shipping Board vessels. While such methods are nothing less than vicious, they are but akin to tipping hotel waiters, hat holders, Pullman porters and the whole gamut of the gentry who hold out their hands for something to which they are not entitled. While it is probable that no similar grafting was indulged in when Noah's Ark was outfitted for her forty-day voyage, simply because of the fact that all the inhabitants of the earth were on board, it is doubtful if any other maritime expedition or voyage since that time has entirely escaped from some form or another of this pernicious practice. Human nature is the same yesterday, today and tomorrow, and the only essential differences between our boasted civilization of today and the dark ages are that the engineer has made living more comfortable and Christianity has taught us to curb natural inclinations. The best that man can do to reform his fellowman is to keep a strict watch on the suspected ones; petty graft in outfitting ships can thus be kept in check by improvements in purchasing systems and strict inspections.

This is now being done to the best of the ability of those at present in charge of all Shipping Board activities, and the regrettable thing about this whole investigation is that it brings out at this time certain shortcomings which occurred in the early days when the storm raged the fiercest. After all it is probable that these exposures will act like a thunder shower in clearing up a murky atmosphere. Let all malicious offenders be punished as is their just due, but let us after it is all cleared up look to the future, as that is what we are all most deeply interested in at this time.

Shipping Shows Highest Salvage Percentage of Any War Investment

Looking forward, then, we have one great consolation to be thankful for, and that is, despite the wastage incident to the war there is no activity in which the Government engaged which can show so high a percentage in salvage value as our investment in ships. What we now have on hand cost probably twice as much as their market value today. What other war expenditure can show a present value of anywhere near 50 percent. Some of the ships, due to hasty war construction, are not up to the standard output of normal times, and we had no right to expect that they would be. When riveters had to be made out of bartenders, barbers and baseball players with only two or three months' training we have no right to criticize the work they did. Fortunately the bulk of the fleet, although contracted for and commenced during the period before the armistice, was largely constructed within the

past two years, when hasty construction was not an object and where the efficiency of the new men drawn into the yards has constantly increased. After the undesirable wooden ships and the small steel ships are disposed of in the best manner possible under the circumstances we will have remaining a fleet of American ships that will compare favorably with the ships of our competitors, and, in fact, as we had a relatively small number of older ships to bring down the average efficiency it is probable that our entire fleet will be superior to any other in the world, as other nations will still have a large percentage of the older ships to lower their average efficiencies.

It cannot be denied that freight rates at this time are all shot to pieces. They have tumbled over 50 percent in six months' time, largely due to the inexorable law of supply and demand. Our principal customers in international trade are not yet on their feet in a productive way, consequently they have but few manufactured goods to sell us. For the past three years our ocean commerce has been largely a one-way transaction, as attested by the large number of American ships which return to our ports in ballast. Statistics show, however, that normal conditions of trade are rapidly approaching. Our exports for this year will exceed our exports for the preceding year, yet this gain is but small in comparison with our rapidly increasing imports as European countries are resuming output. Based on the ocean trade of today, if the United States does 60 percent of its own sea carrying, and even with the current freight rates the estimated revenues from that source will be over $600,000,000 per annum. This will represent a gain in pre-war conditions of possibly a half billion dollars in our national revenues.

National Revenues Increased by Shipping

It has been estimated that Great Britain, the greatest of all sea carriers, received as revenues from her shipping in the last calendar year approximately $2,300,000,000. It is this indirect income which enables that empire to offset what would otherwise be a hopeless balance of trade against her. Heretofore it has been a great problem for America to maintain her balance of trade with the incessant drain on our resources to pay interest on American securities held abroad, augmented by the millions of dollars spent annually by American tourists abroad. Added to those was the incessant drain on our resources in payments made to foreign shipowners and marine insurance underwriters in maintaining our sea commerce. It has been claimed that it took the entire revenue from our cotton exports, of which we have had practically a monopoly, to offset these very serious inroads on our debit side of the ledger in international trade.

We therefore approach the new order of world conditions with the United States occupying the premier position in the world's financial standing. We have stopped the drain on our financial resources because of excessive interest payments by purchasing the greater part of our securities formerly held abroad and we may reasonably expect the principal nations of Europe at no distant date to be paying interest to us on the enormous loans made to them in the time of their national needs. We have our own ships and may reasonably expect to keep the bulk of our expenditures for ocean carrying and marine insurance within our own borders. To accomplish this latter we must, however, exercise reasonable business acumen, which we are well capable of doing, and reform our ways from the reckless methods which we have already fallen into in dealing with our shipping. It is to this latter problem which we must apply our best efforts.

An "Adjustment" with American Shipowners Necessary

It will be sinful for us supinely to lie down at this juncture and say that the problem is hopeless. While we must admit at the outset that the expense of operating our ships will be greater than that of our competitors from the simple fact that American standards of wages and living are now and probably always will be higher than those of any other nation. This must be recognized and means provided for offsetting it. As President-elect Harding has so ably expressed it, there must be an "adjustment" with American shipowners to offset the additional expenses placed on our shipping by the requirements of the Seaman's Act.

What form this "adjustment" will take remains to be developed. If it must be a direct subsidy, I am firmly of the opinion that the American people have become educated up to the point where to insure the permanency of our immense national investment in ships, and to capture the prize of retaining within our own borders the immense sums to be derived from carrying the bulk of our ocean-borne commerce with its concomitant insurance, even that method will be forthcoming from our law makers. Yet it is hoped that with the laws already on our statute books in the shape of the much discussed Jones bill, this direct subvention will not become necessary.

Preferential Duties Clause of the Jones Bill

The preferential duties clause of this act is possibly the way out, and it remains to be seen if the new administration will not be able to repeal the treaties, so vitally necessary for the proper enforcement of this legislation, without seriously jarring amicable relations with the nations involved. Potentially this method of preference to our own ships is very promising. It is by no means a new procedure, as history records that one of the first acts of the continental Congress was the passage of a measure giving goods imported in American bottoms a 10 percent preference in tariff rates. It is also a matter of history that as a direct result of this preference, American shipping increased over 400 percent in the short space of five years. If the present authority for a 5 percent preference in tariff rates does only half as well, there need be no anxiety as to the future of our merchant marine efforts.

Preferential Railroad Rates

The preferential railroad rates to be granted for goods exported in American bottoms is another very promising method of applying this "adjustment" to American ships. It will take time to develop just how beneficial these laws will be. In the meantime an era of rigid economies must be commenced by our ship operators.

How Operating Expenses Can Be Reduced

The officers and men who man our merchant ships must recognize that they must do well their parts to make our merchant marine a success. Their very livelihood depends upon it. While receiving the better pay and better board they must recognize that it is incumbent upon them to cut out everything resembling graft; they must improve their efficiency and greatly reduce the onerous repair bills with which American ships have been inflicted on account of inefficiency and laziness on the part of many of them in responsible positions. They must at once recognize the fact that American ships cannot compete with foreigners, if, in addition to the higher rates of pay they receive, they make insistent demands on owners for "overtime" in doing work which they ought to do during their regular eight-hour shifts. These demands are akin to the largess paid to old-time pirates; all patriotic American merchantmen should unite in cutting out this expense at once. It may have gone all right when freight rates were profligate, but in these days and the days to come it will no longer go. Let that be the first contribution to the good of the cause, on the part of the officers and men operating our ships.

While the greater proportion of our merchant shipping must be confined to the carrying of freight, it must not be

forgotten that we have made a good start and have a somewhat pretentious programme in passenger carrying on the seas. Already new lines have been started to Europe and South America and are giving evidences of success. Other lines are to be established to the Orient, and as fast as the ex-German liners are reconditioned and the twenty or more new ships, originally started as troop transports, are completed, they will be placed in commission to carry ocean travelers under our flag.

American Enterprise Evident in Passenger Service

Although this business is somewhat new to us, there are already pleasing evidences of American enterprise and brains being exercised to make travel on our ships attractive. Fortunately for our efforts there is such a shortage in passenger carrying vessels that rates are being kept at a very high level, in many routes over twice the pre-war tariffs being received by shipowners. There are thousands of emigrants waiting in Europe to be transported to our shores. Many thousands of our own citizens who have not been able to indulge in the great American pastime of visiting foreign lands, for a period of over six years, are anxiously awaiting the time when they may pawn their Liberty bonds and visit the battlefields of Europe. Many of them will prefer the novelty of sailing under the American flag, despite the rigors of a dry passage incident to our nation-wide efforts at prohibition.

Anticipating the influx of thousands of emigrants of the Jewish faith, one American vessel is already fitted up as a Kosher ship and will undoubtedly by this means secure much of the Hebrew patronage.

A novelty, believed to be the first time ever tried on passenger vessels, is the fitting of moving picture outfits on several American ships running to South America. By this means it is hoped that the ennui of a long ocean voyage and the qualms of sea sickness may be somewhat alleviated by nightly reproductions of the latest antics of Charley Chaplin, or mayhaps the more soothing acting of Mary Fairbanks. In any event, it shows that our American ship operators are alive to the desirability of pleasing their patrons.

Another incident which shows the humane side of our new operators is the practice recently adopted by a new American passenger line of furnishing each third class passenger with a neat package containing one day's rations in the shape of sandwiches and like articles of food when they leave the vessel. This serves to protect the newly arrived until they embark on trains or obtain regular boarding places from the ravages of waterfront profiteers.

In the matter of passenger carrying, American vessels will undoubtedly benefit to a greater or less extent from certain racial or national prejudices and predilections. For example, the philanthropic attitude of the United States on all occasions of national disaster will undoubtedly attract certain nationalities to travel under the flag to which they may feel indebted for past kindnesses on our part.

Outlook for Shipbuilding

The outlook for new ship construction is at the moment admittedly very dark. One prominent shipbuilder recently remarked to the writer that if any one now should even hint to him that he thought of building a new ship, he, the shipbuilder, would probably chloroform him, so that when he regained consciousness he would find in his hand a signed contract. We are not alone in this sudden cessation of building activities, as conditions are said to be even worse in the United Kingdom than they are here.

Nevertheless and notwithstanding, we undoubtedly will soon begin the construction of many new ships of special types in order properly to balance our merchant fleet. The whole thing appears to hinge at this time on the exorbitant costs of labor and materials. We cannot reasonably expect shipowners to load themselves down with new vessels at the present high prices and have them eat themselves up with depreciation, capital and insurance charges based on such high original costs. The commodity prices are tumbling more rapidly than they ever went up in a like period. These but presage the great liquidation which is bound to occur in the labor market in the very near future. Men of vision and experience in industrial affairs predict that the month of January will witness the beginning of the very rapid recession in costs of both labor and materials.

Incentives for Building New Ships

But a few months of dwindling costs will unquestionably bring out a lot of new ship contracts. Plans are already completed for at least six large American passenger vessels, which will be given out just as soon as conditions warrant it. The tax exemption clause of the Jones bill, already taken advantage of for the construction of over 300,000 tons of new vessels, will be a strong lever in encouraging a much greater investment before the next year has passed. Then, too, there is the allurement of cheap capital offered to prospective ship owners by the authorization of $25,000,000 of Government money annually for a period of five years, to aid in the construction of highly efficient new ships.

Altogether things are not so dismal as we might be led to think in our merchant marine matters. We have made a tremendous start and the very momentum of a three billion dollar investment in shipping is bound to crush all obstacles. We cannot turn back even if we were inclined to be weak-hearted. There is just one course to pursue, and that is straight onward. We can already point with pride to certain phases of the shipping problem which are now well advanced. Americans are going to sea in ever-increasing numbers. Industrial depression on land will cause a great impetus in the recruiting of our new ships, and it will not be long before we can pick and choose our officers and men from among genuine American citizens. We have suffered from the great influx of foreigners among our ships' officers, attracted by the higher wages we are paying, and who in the last analysis are but camouflaged citizens or Americans for revenue only.

American Vessels and Cargoes to Be Insured at Home

Thanks to the acumen of certain of our legislators and marine insurance leaders we are now in a position, through the several operating syndicates of underwriters, to keep the larger part of the money paid for insuring our ships and cargoes in our own pockets instead of enriching the coffers of our very rivals in the shipping business, as has been done heretofore. This insuring by home resources is greatly aided by the possession of our own classification society, so that we are no longer dependent upon our rivals to say whether or not our ships are kept in the proper condition to warrant the assumption of insurance risks. This very humiliating position in which American shipowners were placed is now no longer necessary. Our banks have responded to the demands for foreign representation in order to carry on our business abroad in a very satisfactory manner to all concerned.

Taken altogether, our merchant marine future is still bright; what we must do is to have faith, "carry on," and economize to our utmost.

American Bureau of Shipping Bulletin.—The first number of the *Bulletin of the American Bureau of Shipping* will be issued in January, 1921. It is proposed for the present to make this a bi-monthly issue. The *Bulletin* will carry statistics of shipping compiled by the Bureau and will print special reports received from its surveyors at home and abroad. No charge will be made for the *Bulletin* and no advertising will be carried. The service of "A Directory of Shipping may be added to the future issues.

The New Administration Assumes Responsibility for the American Merchant Marine

BY WALDON FAWCETT

Although the new executive administration will not assume control of the United States Government until March 4 and the new Congress will not assemble in special or "extra" session until the middle or latter part of March, it is possible thus early to appraise with accuracy the general attitude of the "new management" toward the development of the American merchant marine. Broadly speaking, this attitude may be described as unqualifiedly progressive and constructive. Analyzed from the standpoint of the shipbuilding interests, it may be said that, whereas the policy of the new government cannot, naturally, be counted upon to beget immediate reaction in the guise of contracts for new tonnage, it is impossible to doubt that the more virile Federal attitude will have precisely this result during the year 1921.

AN industry that, as in the case of American shipping and shipbuilding, waits impatiently in arrested development upon the turn of the political wheel is apt to acquire a conviction that as soon as a thing is ordered politically it is as good as done. Applying this logic to the present case there was supposition on the part of many shipping and shipbuilding interests that the national elections in November, 1920, in effect, placed the seal of popular approval upon a fully formulated working plan for the maintenance and upbuilding of the American merchant marine. The fact that the President-elect had been for years a member of the United States Senate and was supposedly familiar with all current merchant marine problems rendered it all the more plausible that the new administration should take up the reins of Federal control with a definite and detailed programme on the merchant marine, ready to hand.

New Administration Must Determine Marine Policy

With full knowledge that the confession may cause disappointment in some quarters, the news must be broken that the new national administration has not discounted nor predigested the problems of the merchant marine. The new administration is emphatically, consistently and persistently in favor of a legislative and executive programme that will attain the ideal of the fullest movement of import and export trade in American-built, American-owned and American-operated ships. This article of faith cannot be underscored too heavily. But at the same time recognition should be given to the fact that it has not and could not well have a comprehensive policy covering the details of governmental support of the merchant marine. A moment's reflection on the part of the practical captain of the industry will bring realization that there are many questions of merchant marine policy that can be intelligibly passed upon by the new President only when he has the opportunity to come into intimate contact with them at first hand. And there are other questions of future policy that must of necessity wait upon the trend of influencing legislation. Thus the general revision of the tariff, the inauguration of the "budget system" for governmental expenditures, the restriction of immigration and other projects that are in prospect will all have direct and indirect bearing upon the merchant marine issue, though precisely how remains to be ascertained.

Instead of feeling impatience that the merchant marine policy of the new administration unfolds slowly, the shipbuilding and shipping industries have reason to be profoundly grateful that the newly elected President holds unshaken to his intention, reiterated time and again during the campaign, to do everything within his power to extend and promote the best interests of the merchant marine. Cynics may have been prone to regard these assurances as the fine promises of which a political contest is provocative. And, indeed, history records numerous instances in which presidents have departed from the ideals to which they swore fealty when in quest of votes. In the light, therefore, of the demonstrated frailties of human nature, it is reassuring to find the President-elect, at the hour of his return from a voyage to the Panama Canal, where his mind has been much given to maritime problems, pledging anew the consecration of his public service to the winning of the desired destiny for the American merchant marine.

Harding Favors Government Backing for Shipping

Speaking thus, at the threshold of his career as chief magistrate, Mr. Harding said: "I want to see America the greatest maritime nation on the face of the earth." Referring to the opposition to the principle of ship subsidy he characterized as "utterly blind" the men of both political parties who have been antagonistic to that prerequisite of an adequate merchant marine. Signalizing his own allegiance to the ideal of governmental backing for shipping enterprises, he remarked: "If the LaFollette Seamen's Act represents the conscience of the American people, and I believe it does, then the American Government ought to step in and share the burden it imposes." Finally he declared: "What I want for America is that the ten million tons of shipping built in haste during the war shall be turned over to private management under Government encouragement."

On the authority of men close to President-elect Harding, it may be said that the prospective incumbent of the White House is the more content to rest, for the time being, on a broad, general policy of encouragement for the American merchant marine because he feels that there is now on the statute books ample law to accomplish most of the things that are needed for the upbuilding of the merchant marine. Mindful of the fact that the Republicans have been in control of Congress for the past two years, Mr. Harding is well content to take the existing laws as a foundation for the structure that he hopes to rear rather than to start anew building from the ground up. Moreover, it must be remembered that Senator Harding was a member of the upper house of Congress during the formulation and passage of the Jones Merchant Marine Act and had his part in that task. His attitude, therefore, toward the existing Merchant Marine Act is much the same as it is with respect to the recently enacted laws for the regulation of the railroads—laws, by the by, that have more application to maritime interests than some of us realize.

Jones Act to Be Given a Trial

As transmitted by the counsellors who are closest to him, the conviction of the President-elect is not that the Merchant Marine Act is all sufficient and conclusive but rather that it

affords a working basis from which only minor digressions should be necessary. It may be desirable, when the law has had a thorough working test, to supplement or amend or amplify its provisions. But the incoming chief executive is understood to share the sentiment of the author of the Jones Act and many other national legislators that the merchant marine statute enacted in the spring of 1920 has had virtually no chance to function as intended. The delay in the appointment of the full membership of the Shipping Board, the refusal of President Wilson to carry out certain provisions of the law, and other untoward circumstances are regarded by sponsors of the statute as having modified if not nullified the authorization of the Jones Act. Hence the disposition on the part of the powers that be in the new administration is to have additional merchant marine legislation wait upon disclosure of a clear need for that legislation.

While there is virtual agreement on the part of the new executive administration and the leaders of the 67th Congress that what the American merchant marine requires is not additional legislation but existing laws properly applied, there is no such unity of sentiment regarding the central machinery created to carry out the will of the Government in the shipping field. The future status of the Shipping Board is fully as problematical as it has been painted in recent numbers of Marine Engineering. Indeed, if anything, it has become more conspicuously the butt of controversy as a result of the charges of corruption and incompetence aired sensationally this past few weeks before a special investigating committee composed of members of the House of Representatives.

Immediately following the passage of the Merchant Marine Act there was manifest on the part of the dominant party in Congress a disposition to afford the Shipping Board, as it should be forthwith constituted, every opportunity to "make good." The law makers most responsible for the Jones Act went so far as to express willingness to accept in good faith a Shipping Board dominated by men of opposite political affiliations, if the President would "make good appointments." This spirit has, it may as well be confessed, to a considerable extent, disappeared. The long delay on the part of President Wilson in naming appointees to the Board and divergence of opinion as to the qualifications of some of the men selected have operated to impair to some extent that spirit of co-operation.

Future of the Shipping Board in Doubt

With the presence of new irritants, we find Congressional sentiment arrayed in three attitudes of mind, and at this stage there is ample room for conjecture as to which will ultimately prevail. First, there is the school of thought that favors acceptance of the Shipping Board as at present constituted. Second, is the sentiment that seeks retention of the form of the Shipping Board but the reorganization of its personnel as soon as the new President can make appointments. Third, is the spirit of insurgency which seeks the abolishment of the Shipping Board as an institution and its replacement by a department of the Government, under the direction of a Cabinet officer, devoted to the merchant marine and to such regularly constituted activities of the national Government as bear intimate relationship to shipping and shipbuilding interests. The strong preference of President-elect Harding for the adjustment by compromise of all controversial questions of policy renders it likely that this question of the form to be assumed by the administrative machinery of Uncle Sam's merchant marine "annex" will be disposed of in a manner designed to leave opportunity for the minimum of friction.

While the policy of the new administration toward the merchant marine has thus been assuming form, the Shipping Board, mustering for the first time its full complement of members, has grappled with a problem, consideration of which has caused to stand out in clear relief the need, in a neglected quarter, for co-operation for the fulfillment of the dreams of an American merchant marine. The ideal that has been held up as desirable is an equitable distribution or apportionment of commerce among the several American ports and the steamer lines operating from these ports. It has focused attention as an important objective, thanks to the consideration by the Shipping Board of a plan to give effect to Section 28 of the Merchant Marine Act (known as Public Law No. 261 of the 66th Congress, Second Session). This act was approved June 5, 1920, but the operation of the section in question was suspended until January 1, 1921. The further suspension of this provision of the law, indefinitely or for a period of six months, has been the subject of earnest pleas to the Shipping Board by representatives of commercial bodies and other interests on the Pacific Coast.

Enforcement of Section 28

As our readers are aware, Section 28 is the "heart" of the Merchant Marine Act in so far as it is the intent of that act to confine the American export and import movement to vessels documented under the laws of the United States. From the time the new statute was approved the Shipping Board has declared that it discerned, on the part of foreign shipping interests, and particularly those operating from the Pacific Coast, an effort to provoke opposition to this provision of the law through threat to divert foreign carriers from the American ports on the Pacific to Canadian Pacific ports or to United States ports on the Atlantic or Gulf coasts.

The debate and the alleged campaign of propaganda, pro and con, which has grown out of this situation on the Pacific Coast has made the purpose and prospective effect of Section 28 even more of a controversial issue than it would otherwise have been. The situation has been further complicated for those in authority at Washington by the fact that Pacific Coast interests have shown no spirit of unity. Interests at the north Pacific ports, that have been articulate, have vigorously opposed the enforcement of Section 28, whereas interests in Los Angeles have been equally emphatic in endorsement of the letter and spirit of the section. Ostensibly, only Pacific Coast interests are concerned, since it is only on the Pacific Coast that there are effective the differentials created by the special "export and import rates." Far-sighted students of the situation suggest, however, that shipping and shipbuilding interests on the Atlantic coast have more reason than they realize to give heed to this issue in that, should the foreign vessels in Pacific commerce be diverted to the Panama Canal and thence to Atlantic and Gulf ports, the additional tonnage would impose extra responsibilities upon port, terminal and ship repair facilities that could not fail to have effect.

In recent conferences with the spokesmen for Pacific Coast interests the Shipping Board officials have found it necessary constantly to emphasize the fact that they are permitted to exercise their discretion with respect to Section 28 only in the event that it can be demonstrated to them that there is not available in a given quarter or on given trade routes adequate tonnage to care for the traffic that exists. Congress had in view that its move in behalf of the upbuilding of an American merchant marine should not, however worthy its intent, operate to restrict commerce coming or going. Accordingly it requires the Shipping Board to certify to the Interstate Commerce Commission and the Commission to suspend the provisions of the Section where American shipping facilities are inadequate. It was in accordance with that reservation that Section 28 was held inoperative throughout the calendar year in which the new law came into existence.

To the dismay of Shipping Board officials most of the representatives of shipping and shipbuilding interests and spokesmen for commercial bodies who have, at the close of the year, appeared to press their views with respect to the permanent policy to be formulated under Section 28 have shown a disposition to discuss the question whether there is

justification for the presence in the law of that significant section. The Board has found it necessary to admonish almost every person who has sought a hearing that this is not the point at issue. Broadly speaking, the Board has no alternative but to enforce the law since it is the law. The only element of doubt arises from the question whether the time is yet ripe to apply the new exactions. And just here it may be added that the Shipping Board has never had any contemplation of a sweeping application of Section 28 to all trade routes. All that has at any time been contemplated was the inauguration of the preferential system with respect to certain ports.

Is the Supply of American Tonnage Adequate?

The crux of the matter then is the question whether or not the supply of tonnage of American registry is "adequate," inadequacy of tonnage being the only allowable excuse for suspension of the requirements under Section 28, and to this conundrum the Shipping Board has sought to confine the remarks of its volunteer advisors, although the concentration has not been attained without some difficulty. Meeting the limitations of the discussion, the spokesmen for commercial bodies have insisted that there is in fact a shortage of American tonnage on the Pacific Coast, at least with respect to certain classes of traffic, and that inasmuch as it cannot be definitely predicted when this shortage can be overcome the suspension of Section 28 should continue, with an understanding that at least six months' notice of enforcement would be given in order that all interests affected might have ample opportunity to adjust themselves to the contemplated conditions.

Maritime men will not miss the fact that in this debate on Section 28 it is the principle of the preferential on the export and import rate that is in reality on trial. Interest in the outcome on the part of various elements on the Pacific Coast is obvious and immediate. But in reality there is in this issue a deal of significance not only for the shipping and shipbuilding interests of the country at large but for the entire transportation industry, because weighing in the balance is the policy that apportions, allocates and distributes the available aggregate traffic among the several United States ports without too fine a regard for bare economies as represented by the length of rail hauls to the respective ports. It has already been disclosed that, if the "base ports" of New York, Philadelphia and Baltimore have only what might be termed a negative interest in this issue, the south Atlantic and Gulf ports have an interest second only to that of Pacific ports.

Distribution of Traffic Among Transcontinental Railroads

The whole discussion is most opportune because there impends an effort to perfect the system of export and import rates as designed to bring about, among other things, a balance of traffic among the transcontinental railroads of the United States. It may be recalled that, during the war, the United States Railroad Administration threw overboard the system that had been worked out by the railroads to equalize traffic. The post-war revival of the old programme was interrupted by the general increase in railroad rates a few months ago. This made necessary a revision of all tariffs and this is yet far from accomplishment. However, in recent conferences at the Shipping Board—conferences in which traffic managers of the leading transcontinental railroads were participants—it was made clear that sentiment is rapidly crystalizing in favor of a system of "equalizing" rail rates as the only adequate medium for the distribution of traffic in proper proportion among all the ports of the United States that are entitled, by geographical position and port facilities, to share in her commerce.

Out of a rich experience as Director of Traffic of the United States Railroad Administration in the war period, Vice-president Chambers, of the Santa Fe system, has counseled the Shipping Board that only by co-operation can this route to the development of American commerce be traveled in safety. He has urged avoidance of all embargoes and expedients to force traffic—the arbitrary policies that inevitably injure certain interests and provoke antagonism. Instead, this railroad executive, whose sentiments have been fervently echoed by others, urges that a system be worked out by all interests—carriers, shippers, shipbuilders, merchants, etc.—making common cause in a conciliatory spirit.

In the name of the San Francisco Chamber of Commerce it has been urged upon the Shipping Board that a conservative policy be at all times pursued in the enforcement of Section 28 of the Merchant Marine Act because of the difficulty of diverting a "trend of traffic," once established. It is obvious that a traffic movement, once started in a given direction, will, if other things be equal, tend to stay there. Applying this moral, the San Francisco representatives have argued that, if virtually the entire export and import movement of the United States be concentrated at a few gateways on the Atlantic coast, it will ultimately come about that American ships on the Pacific, operating from Pacific ports, will be left without cargoes. In this same connection much has been made of the contention that a certain proportion of the commerce to and from the United States will be able to defy the full force and effect of Section 28 owing to the close relations that exist in certain foreign countries between the governments, the manufacturers and exporters, the bankers and the ship-owning interests. A vice-president of the Northern Pacific Railroad has told the Shipping Board that as a result of the "community of interest" that exists in certain ship-owning countries the business that is brought under control through this team work will follow their ships wherever they may go.

More American Tonnage Needed on the Pacific

As for question of the adequacy of available tonnage on the Pacific, on which consideration hinges the future policy of the Shipping Board under Section 28, the best information that has come to the Board is to the effect that there is not American tonnage for all traffic. There is pretty general admission of the fact that United States tonnage may be found for all slow-moving cargo offered at this time. But for the cargo that requires speedy transit—virtually the equivalent of passenger service—the United States documented Pacific fleet is declared inadequate. As will be appreciated, moreover, this is an exceedingly important element of Pacific commerce. It involves the movement from the Orient to the Occident of tea, matting and, notably, silk—commodities of high valuation where the interest rates and insurance rates render time of passage a first consideration. The claim that silk does not at present find adequate tonnage on the north Pacific, in conjunction with the fact that on December 1 passenger accommodations were represented to be booked up to March 1, has been offered in support of the contention that there is a serious lack of a certain class of tonnage. On the other hand, dissenting opinion has suggested that silk might be handled in ships less speedy than those usually considered in connection with this traffic. The judgment of the Shipping Board with respect to its future policy has also been swayed by the fact that it has plans to place in service on the Pacific an increased complement of precisely the class of vessels that are represented as most lacking.

Remedies for Congestion in Ports

The situation that has developed on the Pacific seems bound to lead, ultimately, to the raising of the broader question of what policy will be followed, under the new administration, in enforcement of Section 8 of the Merchant Marine Act. This is the section which deals with the promotion, encouragement and development of ports and transportation facilities in connection with water commerce and which em-

powers the Shipping Board to go in quest of remedies for congestion of commerce in ports. There is one school of thought in official circles which holds that the Shipping Board may go ahead fearlessly in enforcement of Section 28, confident that any threatened diversion of traffic such as has been feared by Pacific Coast interests may be corrected under Section 8 by recommendations to the Interstate Commerce Commission with respect to the direction or compulsory diversion of traffic. A contrary opinion holds that whereas such dictation might be acceptable in an emergency, such as arose during the war, permanent "orders" in time of peace for the artificial movement of commerce would be bitterly resented and opposed. Out of the discussion that has arisen is likely to come an indication of the extent to which Section 8 of the new law may be employed to checkmate foreign shipping interests that may attempt to dodge or practice retaliation for the provisions of the Merchant Marine Act.

Effect of Tariff Revision

Of all the policies of the new national administration it is doubtful if any be of greater consequence to shipping and shipbuilding interests than those to be expressed in a general revision of the tariff. The influence might at first glance appear to be indirect, but it is potent and far-reaching nevertheless. It goes without saying that if the vessels of the American merchant marine are to be operated at a profit they must be assured cargoes in both directions at every round trip, and upon this condition of operation the tariff policy of the nation will have important bearing. Similarly, it requires no stretch of the imagination to discern a connection between tariff policy and the preferential treatment for American vessels in the matter of Panama Canal tolls to which the new administration stands committed. Finally, it is plausible that the future tariff policy of the United States may be a factor to be reckoned with in the new status in international trade should there be carried out that provision of the Merchant Marine Act which contemplates the abrogation of commercial treaties or portions of treaties now in effect between the United States and various foreign powers.

With the thought that shipbuilders and shipowners and operators may conceive themselves to be parties at interest in a revision of the tariff, it may be remarked that it is none too early for action if the sentiment of the maritime industries is to be made a matter of record for the benefit of the law makers who will be charged with the task of revision. While it is well understood that the actual revision waits upon the initial session of the new Congress in the spring and may not be completed ere the autumn of 1921, the preliminary hearings, wherein business sentiment is given opportunity to register its wishes, will be carried on during the first three months of the year. These hearings reveal a sharp cleavage, even within the ranks of the Republican party. On the one hand there are the "high protectionists," so called, who seek to "protect" American industry by as high a tariff wall as may be reared. The sentiment for customs duties that would be all the traffic would bear also finds sympathy with those persons who would fain raise as large a proportion as possible of public revenue by this "indirect tax." Opposed to this view, apart from the dissenting voices of free traders, is the sentiment of a considerable contingent in Congress whose members are in sympathy with the policy of "protection" but who hold that if work is to be found for American cargo ships and outlets are to be had abroad for the surplus products of American factories it will not do to crimp the purchasing power of foreign peoples by raising against them a tariff wall so insurmountable that they will have no opportunity to sell their products to the one customer that is in the best position to buy.

Awaiting the will of the new administration, but with a fate difficult of prediction, is the "free zones in ports" issue as expressed in the pending bill "to provide for the establishment, operation and maintenance of foreign trade zones in ports of entry of the United States to expedite and encourage foreign commerce." It has been assumed in some quarters that because this proposal has been endorsed by the "low tariff" advocates it should have scant chance for approval in the hands of an administration avowedly committed to protectionist policies. However, there appears to be sufficient Republican support for the free-zones-in-ports proposition to bring it out of the Commerce Committee and before the Senate, and if it should appear that the project would contribute to the upbuilding of the merchant marine, the proposition is almost certain to be heard from in one guise or another.

The American Bureau of Shipping

Our Own Classification Society Whose Interests Are Those of the American Merchant Marine

ACTING President Homer L. Ferguson, of the American Society of Naval Architects and Marine Engineers, in his address at the banquet of that society held recently, stated that one of the feats already accomplished in our nation-wide efforts at the rehabilitation of our merchant marine was the building up and establishment on a firm foundation of an American classification society, the American Bureau of Shipping.

This desideratum was early recognized as one of the principal obstacles to overcome in the renaissance of our ocean shipping. Without it we would still be dependent upon the classification facilities of our leading rivals in shipping, in order to aid in accomplishing that vital concomitant of a merchant marine, a successful marine insurance system controlled within our own borders by American companies.

A group of the leading American shipowners, marine underwriters and shipbuilders early in 1916, after debating various ways and means of accomplishing this object, decided that the best method of procedure would be to revive the then somewhat somnolent American institution known as the American Bureau of Shipping. This organization, chartered by the State of New York, had then been in existence for nearly half a century, but on account of comparatively small needs incident to an inconsequential merchant marine had very limited facilities for undertaking what was then seen by these men of vision, the classification of the immense fleet necessary to put the United States on the map as a contender in the ocean carrying trade. Donations of sufficient amount were immediately forthcoming from the patriotic supporters of the necessary reorganization, and Mr. Stevenson Taylor, a man well known and respected in the shipping industry, and who possessed the necessary qualifications for this great undertaking, was unanimously agreed upon to head the organization. How well he, with the patriotic backing of many leading Americans, has succeeded in the task was well expressed by Mr. Ferguson in his speech.

Overcoming almost insurmountable obstacles the organization was built up to such a point of efficiency that the United States Government, by Act of Congress approved June 5, 1920, gave it recognition and declared it to be the official classification society for all branches of the Federal Government. It also, by the same act, placed two representatives, one from the Shipping Board and one from the Department of Commerce, on its executive committee.

As a result of all these efforts this society is today capable of furnishing recognized and reliable classification in this country for all American-owned vessels, without recourse to the classification agencies of our foreign competitors. Its surveyors may be found at all the larger American seaports and at all places where ships are built or ship material is manufactured in this country.

Now that the great rush of shipbuilding in this country has subsided and we are about to enter upon normal conditions in all branches of industry, the managers of the society are engaged in perfecting various details which a national classification society should undertake in order to make it of the greatest value in building up our merchant marine in all its branches.

Expansion of the Bureau

As our ships emerged from the building yards and became engaged in transporting our goods to the various ports of the world, it became incumbent upon the Bureau to expand its facilities for survey work at such leading parts of the globe, where they could be of the greatest service to our shipping. Hence its board of managers appropriated a sufficient sum of money to establish exclusive agencies, after thorough investigation as to our needs, at ports most frequented by our merchantmen. Already competent surveyors, American citizens carefully selected, have been located at such ports as Shanghai, Hamburg, Antwerp, Havre, Bordeaux, Buenos Aires, Rio Janeiro, San Juan, Porto Rico, Havana, etc. Non-exclusive surveyors of the Bureau are to be found at nearly all ports where American ships may call, and as rapidly as our trade expands and the conditions warrant, exclusive surveyors will be detailed from the trained force at home to the principal ports not now so covered.

An alliance has been entered into with the British Corporation, the Registro Navale Italiano and the Imperial Maritime Corporation of Japan, whereby all classification work in this country for those societies and all American Bureau inspections in ports of those countries will be looked after by the recognized exclusive surveyors of each nation. At certain other ports throughout the world exclusive surveyors for the members of the alliance will be maintained, where otherwise the condition might warrant the employment of non-exclusive surveyors only for the individual classification societies.

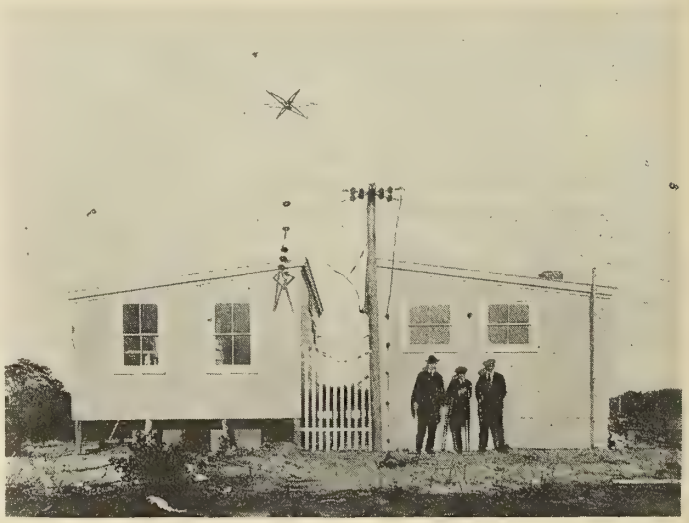
Rules on Internal Combustion Engines

Recognizing the growing importance of internal combustion engines and the inadequacy of all existing classification rules for engines of this type, the American Bureau has recently thoroughly revised its rules for this type of motive power. They are to be promulgated at the beginning of the year, and all who have seen them unite in the opinion that they are the most comprehensive rules yet prepared. In addition to the services of its own technical committee on engineering the Bureau has had the co-operation and advice of a committee of engine manufacturers representative of the industry in this country.

The Bureau's policy will be conservatively to modernize or amend its rules from time to time to keep pace with scientific advancement in the art of ship and engine building, or to recognize and give the advantages of classification to those branches of marine construction which hitherto have, in a manner, been subordinated, or ignored, by other classification societies. An important field of this kind is believed to be the standardization of rules governing the construction and equipment of the various types of harbor and river craft, such as barges, tugboats, railroad floats, river steamboats, both passenger and freight, etc., and the Bureau will shortly undertake to prepare special rules to encourage this type of classification. Marine insurance underwriters of great experience believe that such procedure would be of benefit in eventually reducing insurance rates on this class of risks.

Easthampton Radio Station

ALIVE to the practical needs of shipping, the Cutting and Washington Radio Corporation, of New York, has just opened a new commercial radio coastal station at Easthampton, N. Y., which is located on the south shore of Long Island one hundred and three miles from New York City. This location was decided upon because it was found that with the great number of vessels coming into and leaving the harbor great difficulty was experienced in handling the radio traffic and it seemed advisable to locate a station at a point sufficiently distant from New York to avoid the interference and at the same time near enough to arrange all details of docking, transmitting of commercial messages and allowing ample time for making up of abstracts and other details of accounting. Direct telephone and telegraph wires to New York, together with a selected corps of experienced operators, insures accurate and speedy transmission of all messages sent through this station, the call letters of which are WSA.



New Radio Station on Long Island

The radio station is situated on one of the highest knolls in the town about one mile from the shore. It occupies a plot of ground some six acres in extent. The two galvanized steel towers are 300 feet apart and are 165 feet high surmounted with wooden masts which bring the total height of the antenna to 175 feet above the heavy concrete foundations.

The latest developments in antenna and counterpoise are used, the antenna being of the cage type found so efficient on battleships during the war; the counterpoise is a series of wires radiating from one corner of the radio building and practically covering six acres.

The power supply is obtained from the local electric light company and is brought to the station in a conduit twelve hundred feet long. Twenty-two hundred volts alternating current is stepped down to 220 volts, from which a motor generator unit produces the 110 volts direct current used in the operation of the radio set. A Delco light unit, in conjunction with a storage battery, is used as an auxiliary to provide against breakdown.

Branch Banks Abroad—Their Ability to Co-operate With an American Merchant Marine

BY GEORGE E. ROBERTS*

IN foreign trade we are able to observe the great interdependence of shipping, insurance, banking and merchandising much more clearly than in domestic trade. The advantage of being able to finance, insure and ship the products of the United States that are sold in foreign markets has always been obvious in the past, when this country was greatly lacking in such facilities, and the exporters of America were constant witnesses to the splendid teamwork among the members of the British, German, French or other foreign business communities. But with the changed conditions that arose from and have followed the war, it is imperatively necessary that American products, if they are to hold their own against the competition of the world, must have the assistance of banks, insurance companies and shipping lines under their own flag.

American Branch Banks Abroad Essential for Export Trade

Banking and foreign trade are so closely allied that it is not too much to say that a large volume of export trade is practically impossible without American branch banks located abroad. Conscious of this truth, American bankers of large vision realized as far back as 1914 that if the large foreign trade suddenly thrust on the country in that year was to be made a permanent feature of American business, branch banks would have to be established in the principal countries in which American goods were sold and in which American importers purchased their raw materials. Starting with the installation of branch banks in South America and in Cuba by The National City Bank of New York, this plan to assist, protect and expedite American business all over the world has grown until, under the direct supervision of the Federal Reserve Board, approximately 125 branches of American banks are now being operated abroad.

In the case of The National City Bank, which was the pioneer in the field, the bank realized from the start that if the foreign trade built up so quickly by the United States was to endure after the restoration of peace and the re-establishment of the long-settled business relations between European manufacturers and buyers in the non-manufacturing countries American sales would require the assistance of the same relative banking facilities as those of the nations with whom they must compete. To bring this about meant a large investment without hope of immediate returns in the building up of a very expensive branch bank organization, the assembling of a personnel competent to cope with foreign business conditions and the developing on the part of foreign business communities of confidence in American banks and American banking methods.

That the bank succeeded in what it planned is evidenced by its world-wide system of branches today. Not only have export and import trade been facilitated, but a solidly established system has been evolved which will be of incalculable assistance to American commerce when it is realized that world trade is again back on the highly competitive basis that characterized it before 1914. Within a year or two every advantage won for American business in foreign countries will be needed and it will then be realized how hopeless would be the struggle to maintain a large foreign trade without the accompaniment of broad and sympathetic banking facilities. While what is said here is ascribed to the branches of The National City Bank of New York, it applies with equal force to the other institutions which have established their branches in foreign countries.

American Shipping Dependent Upon Banking and Trade Facilities

The interest of the American merchant marine in this situation is direct and clear. While it is conceivable that a considerable foreign trade might be carried on by the United States and shipped abroad under alien flags, it is inconceivable that the American merchant marine can be prosperously operated without the active and intelligent support of the foreign trade section of American business. The situation is one that cuts both ways and nothing can be clearer than the advantages to be derived from using ships flying the American flag in every possible case where the goods of the United States are to be sent abroad or where American buyers have purchased materials in foreign markets.

At the present time the business world is marking time. Events are in a state of flux from which considerable changes must soon be expected. Production is at a very low ebb all over the world, but consumption goes steadily on in spite of all efforts to reduce it to a minimum. With credit over large areas of the world's surface practically non-existent, and with the exchanges in such disorder that much of the world's normal volume of international trade is paralyzed, it is natural that the shipping industry should reflect such conditions. Great quantities of tonnage are idle, while overhead operating charges run merrily along. However, this distressing situation must eventually right itself. Shipping has ever been a first-class barometer of the state of trade, and it is perhaps fair to say that its periods of prosperity are compensating influences for times of depression like the present, as they are in agriculture, manufacturing and most other industries.

Better Shipping Policy Required

If the foreign trade structure of the United States is to be solidly maintained and the efforts of the banks and foreign traders to keep present markets for American goods is adequately supported, a better shipping policy is required. It is folly to expect that American ships can compete with those of Great Britain, Japan or other nations if the cost of operating American ships is greatly above that of their competitors. Decades of inattention to marine affairs have put American legislation and public opinion out of touch with the world's merchant marine. There is too much reliance in this country on legislative remedies for evils which are economic in their nature and which require economically sound medicine to effect a cure. To wave the flag and talk about the American merchant marine being again a familiar sight in every port is excellent for political conventions, and it graced every one of those held this year, but the world's shipping is a scene of constant struggle and goods are going to be shipped where the rate is the cheapest. Any other course on the part of an exporter than to deliver his goods at the lowest feasible charge would be economic suicide on his individual part and through him on the nation at large.

At the present time private capital and initiative in the United States is wary of investment in ships. There is a feeling, only too well grounded, that the amount of governmental supervision at present exercised over the American merchant marine is fatal to a successful attempt to build up a

* Vice-President, The National City Bank of New York.

sound and profitable merchant fleet. Other countries are removing the restrictions thought necessary as war measures and are allowing their shipowners to operate their property as free lances. No matter how rich or powerful the United States may be, its ships cannot compete on the free seas of the world if their owners are shackled and manacled in the race for business.

The Government Must Quit Shipping Business

It is earnestly to be hoped that the next year will witness a general agreement on the part of all concerned to get the Government out of the shipping business. The recent investigation into the nation's war-time shipbuilding programme can have evoked little but shame from the American people and a general belief that if the American merchant marine is to be successful it will be necessary to institute radically different policies and methods from those that have so far been in vogue.

With the restoration of normal business within the next few months, business transactions will be on a quite different level from those of the past six years. Sellers' markets are not likely to be seen again for a long time. Buyers will be in the ascendant and nothing will play a more important part in the determination of prices for goods sold abroad than the question of ocean freight rates. Money will not go into marine investments unless there is a fair chance for profit and if such a condition as now exists is allowed to become chronic, the same gradual disappearance of the American flag from the seas is inevitable, although for quite different reasons than those which caused its disappearance in the decade following the Civil War.

Shipping Cannot Exist Without Profits

It is unthinkable, after millions of dollars have been invested by large American banks in the establishment of branch banks abroad and after even more millions have been spent by American business concerns relying on the permanent assistance of such branch banks, that unwise legislation should be allowed to hamper shipping, the third great spoke in the foreign trade wheel. Banking, merchandising and shipping are so closely dependent on each other's prosperity, in the foreign field at least, that no one of the three can be truly satisfactory if the rest are not. Capital invested in ships must be allowed to earn a reasonable return, but the ship operators cannot earn such a return unless there is a bona-fide effort on the part of Congress and the Government in general to co-operate in assisting it.

If a sound and workable shipping policy can be devised and quickly brought into operation, American exporters will start in the post-war business race on an even basis with their foreign competitors. The banks have done their part; branch banks are already open for business in every important commercial center throughout the world. What is now needed is a little better teamwork; with that assured, American foreign trade need not worry about retaining an adequate share of the business of the world.

The American Marine Insurance Syndicates

Marine insurance is a very important factor affecting the success of our merchant marine and overseas commerce. Its purpose is to protect our shippers, shipowners and other interested parties against losses which may occur through any of the perils connected with water transportation. It is a safeguard to commerce and exerts a powerful influence in shipping and banking transactions.

ENGLAND leads the world in marine insurance as she does in shipping and shipbuilding. Great Britain recognized long ago the importance of developing insurance along with its shipping and banking facilities not only at home but in every trade center. Insurance companies have been allowed and encouraged to combine into large syndicates and pools and have been permitted to write all kinds of insurance which enables them to reduce overhead charges, to enlarge their underwriting facilities and to meet all the requirements of a client. They are allowed to co-operate with banks through interlocking directorates, and English bankers have arrangements with insurance companies whereby they can provide insurance for their clients. England has also aided marine insurance by not imposing unreasonable taxes, and as a result has reaped the benefit of the intelligent policy that her shipping, banking and insurance interests have pursued through a proper association of their business interests.

American Marine Insurance

The principal obstacle that has prevented the growth of American marine insurance has been the conflicting and harsh laws of the numerous states. Some of these laws were made considering only the regulations thought necessary for fire insurance without taking into account the fact that marine insurance is vitally different. Again, other restrictions were made at a time when it was thought necessary to protect the public against schemes and practices that are now obsolete.

The principal restrictions referred to above should be corrected as follows, viz.: (1) American companies should be allowed to write all forms of insurance excepting life, so that one company could accommodate the full requirements of any client, including casualty, compensation, protection and indemnity; (2) the system of taxation should be based on net profits rather than on gross premiums, as this system is not equitable and does not take the various losses that are bound to occur into account; (3) there should be uniformity in the insurance laws of the several states so that there would not be a multiplicity of conflicting regulations; (4) the laws regarding American companies doing business abroad should be modified to properly recognize the deposits that have to be made in foreign countries and the money that is due them from foreign reinsurers; (5) American companies should be permitted to enter into proper pools, syndicates or combinations, as marine insurance is an international business. The Federal Government has recognized this and the states should follow.

The American Marine Insurance Syndicates

An epoch making and radical departure in American marine insurance practice was started when the American Ma- fire insurance without taking into account the fact that marine and co-operation of the United States Shipping Board on June 28, 1920. These syndicates represent an effort to form a distinctly national policy, and for the first time American companies have combined to maintain a comprehensive service in insurance matters including inspections, surveys, etc. The following is an outline of the principal features of the three newly organized syndicates.

Syndicate A

Syndicate A (Service Syndicate) was organized to perform, at cost, surveying, inspection and loss surveys for the United

States Shipping Board in respect to all steel vessels owned by the board or sold by it on a part payment basis, and to perform similar service in respect to any vessels for any other shipowners and marine underwriters upon payment of reasonable charges for such service. The syndicate shall create and maintain an organization for inspection, and damage and loss surveys, and to advise all interested parties with respect to matters relating to inspection, repair, equipment, loading, management, operation, efficiency, safety and damage to, and salvage and loss of, vessels. It is not the intention, however, that this syndicate is to take the place of or perform the work of a classification society. Vessels are to be inspected approximately every four months, and the maintenance inspection shall show the condition of hull, machinery, galley, crew's quarters, and all parts of the vessel. Membership is limited to strictly American companies, but is open to all such companies as meet reasonable conditions of solvency and fair dealing.

Syndicate B

Syndicate B was organized to insure all American steel steamships which the United States Shipping Board may hereafter sell to others, to the full extent of the unpaid purchase price thereof, and also, to a like extent, such other American steel steamships heretofore sold by the board as are acceptable for insurance to the syndicate. The syndicate is to have an underwriting capacity of not less than $2,000,000 upon a single hull. Every company subscribing to the syndicate has allotted to it a definite percentage of every assumed risk accepted by the syndicate underwriter. Rates of premium and policy forms may be altered as conditions require upon 10 days' written notice to the Shipping Board. The liability of the companies is several and not joint. Membership is limited to strictly American companies, but all such companies are acceptable if they meet reasonable standards of solvency and fair dealing. The subscribing companies agree to reinsure only with strictly American companies.

Since the operation of this syndicate is limited to the insurance of the Government's interest (the unpaid portion of the purchase price) in vessels sold by it, it follows that as the various installments of the unpaid purchase price are paid the Government interest in the vessels protected by this syndicate will decrease, while the private interest of the owners will proportionately increase. Syndicate B will therefore be a gradually diminishing syndicate, whereas syndicate C will be a growing syndicate.

Syndicate C

Syndicate C was organized to insure all American ocean-going steel hulls when approved and accepted for marine insurance by the syndicate managers, and owned by private persons or corporations or in which they have an insurable interest. The syndicate has a total underwriting capacity of not less than $2,500,000 upon a single hull. The liability of all subscribers is several and not joint, each subscriber being committed in respect to each policy insured by the syndicate underwriter for the subscribing member's preagreed percentage written opposite its name on the list of subscribers.

Membership is divided into two groups. One group, representing at least two-thirds of the amount underwritten on any risk, consists entirely of strictly American companies; that is, companies chartered under the laws of the United States or of any state thereof, domiciled therein, and not controlled by foreign interests. The second group, representing not to exceed one-third of the underwriting capacity of the syndicate, shall consist solely of subscribing companies of foreign countries duly authorized and licensed to transact marine insurance in the United States.

Each syndicate subscriber may accept additional insurance on American hulls, outside of the syndicate arrangement, but cannot do so at rates lower than those quoted by the syndicate. Nor can such additional insurance be reinsured in part or in whole outside of the syndicate, unless the syndicate declines to accept the business; nor shall such additional insurance diminish the underwriting obligations of such subscriber as a member of the syndicate.

Matters Not Covered by Syndicates

Syndicate A is not allowed in any way to perform the work of a classification society, and neither Syndicate B or C may take cargo insurance. It is not intended to accumulate or invest the funds of Syndicates B or C, but to distribute the premiums as promptly as possible.

Membership

Membership in Syndicates A and B is limited to American owned and controlled insurance corporations, but membership in Syndicate C is open to foreign admitted insurance companies to the extent of one-third the underwriting interest, the other two-thirds being reserved to American companies. It is intended that membership in the syndicates shall be open to all qualified insurance companies and that the liability of each company shall be limited to the extent of the proportional share that each subscriber has agreed to assume in each syndicate.

Management

The three syndicates are to be managed by a single board composed from the representatives of nine subscribers, two of whom are representatives of foreign companies admitted to Syndicate C. An increase in the number of managers in order to give a wider sectional representation and the appointment of the manager of Syndicate A as an *ex officio* member is now under consideration. The chief underwriter is now an *ex officio* member and the United States Shipping Board has also the right to appoint an *ex officio* member who may attend those meetings of the board of managers that are held in respect to the affairs of Syndicates A and B.

The board of managers and the periods for which each member thereof shall continue in office are:

Subscriber	Representative	Term, Years
Home Insurance Company....	Louis F. Burke	1
Boston Insurance Company...	William R. Hedge	1
London & Scottish Assurance Corporation	Douglas F. Cox	1
Atlantic Mutual Insurance Company	Walter W. Parsons (vice-chairman)	2
Globe & Rutgers Fire Insurance Company.....	Edwin C. Jameson	2
Aetna Insurance Company....	Samuel Bird, Jr.	2
Insurance Company of North America	Benjamin Rush (chairman)	3
Continental Insurance Company	Gomer H. Rees (secretary)	3
Sea Insurance Company.....	Hendon Chubb	3

Mr. Lawrence J. Brengle, formerly with Johnson & Higgins, and later with the Insurance Company of North America, is chief underwriter. Mr. Charles R. Page, formerly with the Firemen's Fund Insurance Company, and during the war a member of the United States Shipping Board, from which he resigned shortly after the armistice to become treasurer of the Atlantic Gulf and West Indies Steamship Lines, later becoming vice-president in charge of the operations of the Clyde and Mallory Steamship Lines, is manager of Syndicate A.

Offices

The head office of the syndicates is located in the Southern building, Washington, D. C., but the operating and underwriting headquarters have been established in the principal branch office at 44 Beaver street, New York, N. Y.

At the New York office Syndicate A maintains the headquarters of the North Atlantic district, which comprises all ports from Eastport, Me., to the Delaware River, inclusive.

(*Concluded on page* 48.)

Ships and Their Construction

Review of Present-Day Merchant and Naval Types of Ocean-Going Vessels

BY C. H. PEABODY, DR. ENG.

IN reviewing the construction of ships we may say, in the first place, that the steamship has got its growth; the great liners are not likely to be much exceeded in size and power in the immediate future, if ever. Ten years ago Sir William White, in giving a description of the *Lusitania* and *Mauretania,* said that there was no advantage in increasing size *per se*. Those ships could make their twenty-five knots week in and week out in all ordinary weather and run on schedule time as inferred by the phrase, "the Atlantic ferry." Even in heavy weather they were limited in power and speed only by the necessary consideration for the crew and the deck fittings; it is not desirable to carry away lifeboats and ventilators, nor to lose too many of the crew. Since their days, larger and more luxurious ships have been built, like the *Titanic* and the *Gigantic* and the great German liners, but they have less speed. The conditions of their design and construction were economic—what would pay in freight and passenger accommodations.

In another sense, the construction of steamers may be considered to have reached maturity in that shipbuilders are ready to meet any contingency that may arise should there be a demand for greater size or speed.

North Atlantic Not Alone in Race for Passenger Service

Since the North Atlantic has been the field for the race in the construction and speed of ships, we are likely to forget that a like or even a relatively greater development in steamer accommodations has been made on other waters—the Pacific, the Cape route and to South America. Large and commodious steamers are plying on these routes and at good speed. It must not be forgotten that even sixteen knots is a respectable passenger speed over the larger part of the ocean.

There has been recently a notable increase in large and relatively fast freighters; not so much the increase in size of the individual ship, for large ships, principally for freight, have long been common on the Atlantic. Such ships usually carry passengers, but that is a secondary consideration in ordinary times. Special types like oil tankers have shown most notable growth.

Growth of Tanker Tonnage

In a recent meeting of the Society of Naval Architects and Marine Engineers a description was given of a 20,000-ton tanker, with an incidental claim that it was the largest built. This claim was challenged and it appeared that the question, which was the greatest ship, depended on how you reckoned size.

The much discussed fabricated ship appears to have left the field of practical ship construction; it was an emergency measure to meet war conditions and served its purpose.

There is a difference of opinion concerning the ships fabricated during the war; perhaps there is a difference in the ships. The general opinion appears to be that they are rough but serviceable. The case against the fabricated ship has been thus stated by a noted shipbuilder, "A ship is pointed at both ends, and the ends are not alike."

Manufacturing of Ships

As to manufacturing ships, that is a question of specialization and numbers. In American yards everything has been taken from battle cruisers to car floats. Some yards have built locomotive boilers—real locomotive boilers—not boilers of the locomotive type. There has been much criticism that yards have given precedence to commercial work and let naval work drag, but during the war the shipyard was found to be (next to ships) the most precious national possession, and yards were hurriedly built with enormous waste. The shipbuilders would be the last to claim it, but the fact is that the maintenance of a shipyard by any device was a patriotic accomplishment. Of course, the builders were in the business to make money, or to try to make it.

But to get back to manufacturing ships. The great shipbuilding nation, Great Britain, has long specialized, some yards building certain types and other yards building others. Some yards had a monopoly of building for certain lines of steamers, a monopoly due to good service and good understanding. The company merely said, "Build me another ship." It might be like or different—the details were the affair of the builder. Even with a degree of specialization it cannot be said that ships were manufactured unless it be of a certain yard building so-called turret steamers, which, by the way, were not properly turreted, for turrets, whether on a castle or a warship, are round, and the steamers mentioned carried a high and narrow deck right fore and aft. But the type of steamer was unimportant; the important matter was that the shipbuilding company chose a type and certain limited sizes and went on building them whether there were orders or not. Everything was arranged for expeditious construction. The ordering and reception of material, working and transportation of material in the yard, launching and fitting out—all went on systematically. Every six weeks a ship was launched, and as soon as one ship took the water, material already prepared was brought onto the slip for the keel of the next ship. To such an extent was the construction manufacturing, that the yard had scarcely any drawing room force. That is the way to manufacture ships. Somewhat the same thing was done by an American yard during the war for destroyers, which were all of one type and built in bunches of five. Whenever and wherever ships are wanted in bunches they can be manufactured.

The Wooden Ship Has Had Its Day

During the war there was a turning back to wooden construction in order to get more and more ships without waiting till the rolling of plates and shapes could catch up with orders. These ships are now for sale with no bidders. Except for small construction and special service, the wooden ship has had its day. It is a fair guess that a wooden ship will hereafter have its keel in one piece and that ships that are longer than such construction makes possible will be made of steel. As for the concrete ship, it may be said to have "died abornin':"

Warships

Though it may be too soon to speak with confidence, it appears that the war has shown the relative importance of warships to be in the order of battleships, destroyers, battle cruisers, submarines, transports and cruisers. The sea was, and probably will be, dominated by the battleship that can give and take hard knocks. The fact that there was no conclusive action between battleships proves only that the weaker party had discretion. A fleet-in-being is always a danger until it is destroyed or surrendered. The destroyer, preferably as big and as fast as possible, is to the modern fleet what the frigate was in the days of three-deckers—the attendant,

the scout and the screen. The other services, especially in convoying, were most prominent in the late war because the battle fleets spent most of the time in reserve; really, the convoy duty should be by ordinary cruisers or even armed merchantmen.

Probably the real duty of the so-called battle cruiser is to sweep the seas of enemy craft so that commerce may be safeguarded. They can drive away or destroy all ships but battleships, but they cannot stand up under heavy fire.

At one time it appeared that the submarine would win the war; it was a new weapon against which the defence was not yet found. Even if the barbarity of sinking merchantmen without warning should be accepted as a necessary part of some future war, that war will not be won by the submarine.

Importance of Merchant Vessels in War

The importance of merchantmen, and especially of large and fast passenger ships for transports, was the real lesson of importance for our country. A war may be decided by the navy or even by a single naval action. This truism goes back to the battle of Salamis, for Xerxes did not go home because he was a coward, but because the game was up when his line of transportation for his great army was destroyed. But generally a war is determined by the foot soldiers, and we need ships that can carry our soldiers where they must go to end a war. In many cases the threat will be sufficient perhaps before the war has begun. Cruisers are put at the end of the list because it cannot be expected that they will decide a war. The old chivalric tacit agreement that frigates should not be fired on if they would only keep out of the way might well be extended to cruisers which should chance into a main action. A cruiser is, however, a man of all work in peace and war, and perhaps it should not be relegated to the last class of warships.

No mention has been made of airships or airplanes. Under certain conditions they may be of great value as scouts or for locating submarines or mine fields; as a weapon against ships they have accomplished nothing. It is possible to drop bombs from either airships or airplanes on or near a city.

All the types of ships have reached their growth, unless perhaps it may be submarines. At least this is to be hoped for, where our latest battleships of 42,000 tons displacement and 23 knots speed carry twelve 16-inch guns and our battle cruisers have 34,800 tons displacement and 35 knots speed and carry ten 14-inch guns. Our later destroyers laid down are to have a speed of 35 knots, the same as the battle cruisers; they cannot hope to maintain such a speed in rough weather as can the cruisers. As for the submarine, it properly depends on the internal combustion engine and is a small and feeble craft, depending on stealth. One British "fleet submarine" having steam turbines to give a speed of 24 knots has had its trials; what its scope and duties may be does not yet appear.

Propelling Machinery

Coming now to the propulsive machinery, we have steam engines, steam turbines and internal combustion engines, together with mechanical and electrical gearing; the latter is known as the electric drive.

The old reciprocating engines came to maturity forty years ago and there has been no material change except increase in size; now it is threatened by the steam turbine and the internal combustion engine.

The marine steam turbine is the ideal propelling engine for a ship. It is the designers' and the builders' machine, shut up in a box and requiring intelligent care to see that it remains in line with its clearances intact; also the lubrication must be continuous and sufficient. The direct turbine drive of large passenger ships appears to be completely worked out, as is also the geared turbine for destroyers and the double geared turbine for freighters. Many geared turbines for freighters, hurriedly built and installed during the war, have given trouble, which has not been less in the hands of hurriedly trained crews. Now such machinery by good builders can be depended on if intelligently cared for.

The electric drive was invented to maintain reasonable economy on warships at cruising speeds. That purpose it accomplishes admirably, and perhaps the success of our battle cruisers may be conditioned absolutely on the electric drive.

Both mechanical gearing and the electric drive find an ideal motor in the turbine with its high speed and uniform torque. A double geared steam turbine has a curious appearance, with the gears larger and many times as heavy as the turbine itself. The gears, like the turbines, are the builders' machine and call for little but intelligent care from the engineers to see that they are kept in alinement and in proper gear and that they are properly lubricated.

Diesel Engines and the Motorship

The internal combustion engine, of either the Diesel or the hot bulb type, has been completely adapted to sea service, with standard methods of building, installation, operation and maintenance. The auxiliary service is not yet completely standardized, it being uncertain whether it is best to have a donkey steam boiler to work auxiliaries directly by their own internal combustion engines or to install a general electric system using internal combustion engines. There appears to be no controlling objection to steam auxiliaries either burning oil or carrying coal for that purpose. The ideal system appears to have a sufficient electric plant for all purposes except propulsion, including heating and cooking. The Diesel engine, having a supply of compressed air, can use it for various auxiliary purposes. The hot bulb engine can be made of all sizes and is now adapted to hoisting and pumping.

In order to reduce weight, the Diesel engine is run at higher speed than that desired for best economy of the propeller. Whatever disadvantage comes with smaller diameter and less pitch ratio is accepted as a slight offset to the great advantage of excellent fuel economy. Both ways of reconciliation that have been applied to steam turbines are under consideration, namely, gearing and the electric drive. While the turbine is well adapted to driving through gears, the internal combustion engine is not, on account of its irregular torque and the dynamic forces acting on the pistons. The electric drive shows possibilities; the gain in propeller efficiency will probably be more than the loss through electric transformation, and the maneuvering of the ship and arrangement of auxiliaries will be simplified. It will be possible to have as many engines as can be conveniently carried, all of which can drive a single screw or twin screws.

Increasing the Power of Diesel Engines

The real question of the internal combustion engine is to provide more power. Though certain European builders are ready to contract for engines to deliver 500 horsepower per cylinder, it is not known that any are in service. The difficulties are thermal and are likely to develop in service; if not now met they probably will be. Now the ideal internal combustion engine has six cylinders, so that it may be completely balanced; six cranks are surely enough for any engine. At present the power per cylinder is not much more than 300 horsepower, so that a six-cylinder engine may give 2,000 horsepower; with twin screws double that power can be used conveniently.

By far the greater number of freighters may be driven by internal combustion engines as now built. As already suggested, electric drive is well adapted to gear up this ideal engine with the best propeller, and if three or four engines can be installed the range of power can be just so far extended. Even so the range of power is limited and the great ships are likely to remain steamers. Incidentally, an electric drive would provide at the same time for all auxiliaries.

Electric Ship Propulsion

Comparison of Electric Propulsion With Geared Turbine Drive in Merchant Vessels

BY W. L. R. EMMET*

THE advantages afforded by the electrical method of ship propulsion are largely dependent upon conditions and specific cases must be studied in detail in order that just comparisons with other methods may be made. For example, in large battleships there is a very great advantage in interchangeability and adaptability to economic operation under widely different conditions of service, also a greater safety and convenience in arrangement in the ship without any disadvantage in weight or space occupied, while in such a vessel as a high power destroyer limitations both of weight and space would constitute almost prohibitive disadvantage.

The argument for electric drive in large warships may be said to have been concluded after many years of controversy by its general adoption by the United States Navy in the vast building programme now in progress and by its unqualified success in the battleship *New Mexico*.

In merchant ships the advantages are less obvious and less generally admitted and are, therefore, most worthy of careful study at the present time; and the comparison which is most important for present needs is that between the electric propulsion from steam turbines and the application of steam turbines by means of mechanical speed reducing gears.

While the Diesel engine is being extensively applied to ships, it is obvious that the extent and scope of its use are limited, and, since the bulk of production is of steamers, we may justly confine our present study to the comparison just stated, although electricity has also been used in transmission to propellers from Diesel engines.

Propelling Equipment

In applying electric propulsion to a merchant ship we install one or more steam turbine generating units. Large turbines are more efficient than small ones. Therefore, while two or more turbines may be convenient on account of the ability to run with one alone, it is often more advantageous to run ships of moderate power from a single turbine. As will be explained, arrangements can be made by which such a ship can be driven at a reduced speed from the auxiliary generating units in case the main apparatus cannot be run. In such single generating units we can generally adopt such speed as will give the best results for the power delivered, and the freedom to do this is of great importance, since a turbine is more complicated and expensive and materially less efficient if it has to be designed for a speed less than is desirable.

On each propeller shaft a motor, preferably of the synchronous type, will be installed, so designed as to give the most advantageous propeller speed. The first electrically driven ships were equipped with induction motors, but synchronous motors are lighter, more efficient, run with a larger clearance and can be built to give the full reversing torque required and to accomplish all the required functions.

Auxiliaries

In addition to the generating and motor equipment, it is desirable to establish an efficient auxiliary generating plant with at least one spare unit. The auxiliary units should preferably be steam turbines, geared to direct current generators, and their power should be used for exciting the main generators and motors, running as many of the ship's auxiliaries as possible by motors and lighting the ship, etc. These units can be run condensing and be so arranged that they can exhaust either into the main or auxiliary condensers. Any steam driven auxiliaries which might be employed should be exhausted into the feed heater, and additional steam, which may be required for feed heating, can be advantageously taken from an intermediate stage of the main turbine.

This auxiliary plant can be used to propel the ship, either using a motor generator set to turn its direct current into alternating of suitable frequency for use in the main motors at low speed, or a direct current motor can be installed so that, if necessary, it can be put into engagement with the propeller shaft by a simple spur gear carried on the shaft for the purpose. The latter arrangement would generally be the simpler and cheaper. Such arrangements, of course, have no functions in larger ships which can be advantageously run with two generators. And, in fact, it may be considered an unnecessary addition, since the properly equipped electric ship, even with a single generator, is more reliable than any other form which uses a single propeller.

Position of Apparatus

In the electrically driven ship the generating plant can be put in the most convenient position with respect to the boilers, and at any convenient level, and the motors can be put as near the propellers as the form of the ship permits; thus, in many cases, saving weight and space for shafting and shaft alleys and also the friction of shaft bearings.

Geared Turbines

The other method of ship propulsion, of which the value should be compared with that of electric drive, is the combination of turbine and gearing. In attempting to make this comparison, it must be remembered that gears have been applied to this purpose in a number of different ways involving various advantages and disadvantages.

The first ship gears produced were of the single reduction type and used, on account of gear conditions, turbines much lower in speed than is considered desirable for other uses, such as the driving of electric generators. Later, in this country, the General Electric Company introduced double reduction gears for ships with speeds considered most desirable both for turbines and propellers, and with a consequently more complicated gear arrangement. Following this lead, double reduction gears were produced to meet the war emergency by all the large American producers, and later a number of English makers went to the double reduction type at the same time that some American makers were changing back to single reduction.

There have been many troubles with ship gearing and many theories as to the causes of these troubles which will not bear comparison with the facts. The General Electric Company has built more ship gears than any other manufacturer, with the possible exception of the Westinghouse Company, and we have kept careful track of troubles with gears including many of different makes. Our observations indicate that there is still great uncertainty in the gear situation and that there is no type of gear which has, in all cases, given reliable service.

In deciding upon the relative merits of gear and electric drive, it is obviously desirable that causes of troubles in gears

* Consulting engineer, General Electric Company, Schenectady, N. Y.

be proved with some degree of definiteness and consistency. There has been much theorizing on this subject which will not bear comparison with the facts and some definite experimentation which deserves careful consideration.

Possible Causes of Failure in Ship Gears

While, undoubtedly, many such gears have failed through neglect, improper lubrication or improper installation, there have been a great number of failures to which no such causes can be assigned. It has been repeatedly proved by experiment that similar gears on shore will bear, without deterioration, loads as much as four times as great as those which have caused rapid failure with perfect installation and care on ships.

Tests have been made with a torsion device between a ship gear and the propeller which showed periodic increases of torque as high as 50 percent through influence of ship's motion and waves upon the propeller. This was in a moderate sea pitching 4 degrees, and such effect may be much greater under some conditions, but cannot account for such differences of performance at sea and on shore as have been stated.

Another test has been made which may throw much light upon a possible reason for such excess pressure on the engaging surfaces of gears as might cause the pittings and destructions observed. A light, stiff arm was attached to a bearing cup at the middle of a ship gear, with multiplying devices to show relative motion between the ends of this arm and the corners of the gear casing which carry the other bearings. Obviously any movement here shown indicates a springing of the structure and a variation in the alinement of the bearings.

The tests made with this device showed various degrees of movement under different conditions and directions of the sea. With a rough sea directly following there was practically no movement, while with a rough, quartering sea an amplitude of movement as great as .05 inch was observed. While the method of measurement may have somewhat magnified the actual distortions of the gear casing, it is obvious that even a fraction of such movements might account for immense increases of pressure on points of gear engagement. The marked effect of direction of the sea in these tests explains the possible reason why ship gears suffer heavily on certain voyages and not on others.

Efficiency of Gearing on Ships

Many claims of very high efficiency for ship gears have been made, but few of these have been based upon properly conducted test data. The General Electric Company has conducted several careful tests of ship gears accurately set up on shore and run at various speeds and actually transmitting power up to full load. Under these conditions the operation was perfectly smooth and practically noiseless, and the efficiency must have been better than that at sea with possible variations of pressure in gears and bearings.

These tests show that gears are much more efficient at heavy load than at light load and that at low tooth speed the efficiency is better than at high. Thus, if we adopt very conservative designs which give low tooth pressures we get relatively poor efficiency, and if we use high turbine speeds and gear speeds the efficiency of transmission is relatively low.

As experience has developed, gears have been made larger and larger with lower tooth pressures and it cannot be positively said whether the end of such increases has yet come. But, on the basis of standards which have recently been adopted, these tests indicate that, even under test conditions, the double reduction gears now being produced should not be more than 94.5 percent efficient. In this connection it should also be remembered that careful tests have shown that reversing turbines, designed for good torque, introduce losses ranging from 1 percent to 1.5 percent. There are also additional packing and other losses, if high and low pressure turbines instead of a single turbine are used, which is the general present practice in geared ships.

Single reduction equipments, as generally applied, are more efficient in gear transmission—possibly 97 percent—under most favorable conditions with conservative pressures, but there are few cases in commercial ships where single reduction can be used without sacrifice in the quality of the turbines.

Thus, under most favorable conditions, the net efficiencies comparable with electric transmission are not better than 93.5 percent for double reduction and 96 percent for single reduction, including reversing losses, etc. Electric transmission will give about 92.5 percent for small powers and 95 percent for large powers. This small difference will certainly be more than equalized—probably very much more—by the irregularities of gear operation at sea as indicated by wear and pitting and by loud noises emitted in rough weather.

Mechanical Conditions in Electric Propulsion

In electrically driven ships we have no motion but simple rotation and no mechanical engagements except in the bearings. Propellers are free to revolve whether their motors are in repair or not.

Generators and motors of the type and voltage used for such work are practically immune from mechanical or electrical failures and are very simple to repair, either permanently by putting in new coils or temporarily by reconnecting so that they can be run at reduced load. As has been said, arrangements can easily be made by which a ship can be run from auxiliary turbines, if all the main apparatus should be inoperative. A ship having two generating units can be run at about three-quarters speed with one of them and the efficiency of operation at this reduced speed is very nearly as good as that at full speed.

Designs have been worked out by the best experts for ships of different types, including large liners, which, considering all these conditions, show great advantages over gear driven equipment, and it may be confidently expected that electric propulsion will, at an early date, play a very important part in merchant marine activities.

New Wireless Regulations for Vessels Entering British Ports

AMERICAN shippers should note that hereafter all vessels arriving at British ports will be subject to the provisions of the British Wireless Act of 1919, which requires that every seagoing passenger steamer or ship of 1,600 gross tonnage or upwards shall be provided with a wireless telegraph installation. The installation will be expected to comply with the requirements of the International Radiotelegraph Convention of 1912 as modified by international agreement.

The new act stipulates that ships not engaged in the coasting trade carrying 200 persons or more must carry three operators on voyages exceeding 48 hours from port, on voyages exceeding 8 hours but not exceeding 48 hours two operators, and on voyages not exceeding 8 hours from port to port one operator.

In the United States the first act requiring wireless apparatus on certain passenger carrying vessels was approved in June, 1910. The second act, approved in July, 1912, amended the first act so as to cover all vessels navigating the ocean or Great Lakes and licensed to carry 50 or more persons, including passengers or crew, with the exception of steamers plying between ports or places less than 200 miles apart.

This act also requires an auxiliary source of power independent of the vessel's main electric power plant, which will enable the sending set to send, for at least four hours, messages over a distance of at least 100 miles.

Motorship Building in the United States

Although the aggregate tonnage of motorships building in the United States at the present time is only about one-tenth of that under construction in Europe, nevertheless a start has been made towards developing a motorship fleet in the United States, and it is generally acknowledged that most of the larger shipbuilders are preparing to engage in this type of construction whenever the market for this type of vessel appears to justify such a move. Details of the vessels actually under construction and of the various types of engines which are now being built in this country are given in this article.

THE year 1920 marks the real beginning of motorship building in the United States. At the present time there are nineteen motorships, totalling 143,850 deadweight tons, under construction in this country, the total shaft horsepower for these vessels amounting to 44,520. In addition, there are twelve or fifteen vessels now being reconditioned as motorships in American repair yards. Sixteen firms are actually building Diesel engines and twelve other firms, including some of the large shipyards, either have licenses for building Diesel engines of foreign design or are carrying out experimental work on original designs of Diesel engines.

Motorships Under Construction

By far the largest order which has been placed for motorships in the United States is that for four ore carriers each of 20,000 tons deadweight capacity to be built for the Ore Steamship Company, New York, by the Bethlehem Shipbuilding Corporation. These vessels will each have a set of two 2,500 shaft horsepower two cycle Bethlehem-West type six cylinder direct reversible marine Diesel engines. These engines are in every respect similar to the one installed in the ore carrier *Cubore*. The speed of these vessels is estimated at 11½ knots.

At the Gloucester, N. J., yard of Pusey & Jones the motorship *William Penn* ordered by the United States Shipping Board is nearing completion. This vessel has a deadweight capacity of 12,900 tons, a length of 439 feet 3 inches, a beam of 60 feet and a depth of 30 feet 8 inches. Propulsion is by two sets of original Burmeister & Wain six cylinder four cycle 1,750 shaft horsepower direct reversible Diesel engines purchased abroad by the Shipping Board and installed by William Cramp & Sons Ship & Engine Building Company, Philadelphia. These engines will run at a normal speed of 110 revolutions per minute.

The *William Penn* was launched about two months ago and will be ready for service early in 1921. She will be put in a competitive test on a Far East run with the first electrically driven steamer, the *Eclipse*, so as to gain comparative data of cost and reliability of operation.

Two motorships of 11,200 tons deadweight capacity for the American Hawaiian Steamship Company, New York, are under construction at the Chester (Pa.) yard of the Merchant Shipbuilding Corporation. Each of these vessels will be driven by two Burmeister & Wain Diesel engines similar to those installed on the *William Penn*, but they will be built by William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa. These vessels will have a length of 445 feet, a beam of 59 feet 8 inches, a depth of 39 feet and a speed of 11½ knots. As is the case with the *William Penn*, the deck auxiliaries will be electrically driven.

The Union Construction Company, San Francisco, Cal., is building for the Standard Oil Company the Diesel engined tanker *Charlie Watson*, which has a deadweight capacity of 5,050 tons and is propelled by two Skandia Werkspoor Diesel engines of 850 shaft horsepower each running at 135 revolutions per minute. The vessel will have a speed at full load of from 10 to 12 knots. Another tanker of 2,800 deadweight tons is also under construction for the Standard Oil Company at the yard of the Moore Shipbuilding Company, Oakland, Cal. This vessel, the *F. H. Hillman*, is 342 feet long, 46 feet beam, 27 feet depth and will be driven by two 500-horsepower Werkspoor Skandia engines running at a speed of 165 revolutions per minute, giving the vessel a speed of 10 to 12 knots.

At the Newark Bay yard of the Submarine Boat Corporation, New York, a 10,000-ton motorship is to be built, which will be driven by one Craig engine of 2,500 indicated horsepower built by the James Craig Engine and Machine Works, Jersey City, N. J.

Seven 600-ton deadweight concrete tankers are being built for the United States War Department at the Newport Shipbuilding Company, New Bern, N. C., each of which will be equipped with two 450 shaft horsepower 8 cylinder Winton engines running at a speed of 210 to 220 revolutions per minute, giving the vessels an estimated speed at full load of from 13 to 14 knots.

A contract has recently been placed with the Todd Dry Dock & Construction Company, Tacoma, Wash., by the Alaska Steamship Company for a 6,500 deadweight ton cargo carrier to be equipped with two 900-horsepower McIntosh & Seymour crosshead type Diesel engines running at 135 to 140 revolutions per minute. The length of the vessel will be 345 feet, the beam 49 feet 6 inches and the molded depth 26 feet 9 inches.

The Long Beach Shipbuilding Company, Long Beach, Cal., has under construction the yacht *Edythe*, 125 feet long, which will be driven by two 360 shaft horsepower Nelseco Diesel engines supplied by the New London Ship & Engine Company, Groton, Conn.

Motorships in Course of Reconstruction

At the Vulcan Iron Works, Jersey City, N. J., the motorship *Bacoi* owned by L. G. Gillespie & Son, New York, is being changed from a typical Lake boat into a standard cargo carrier. The original Polar engine will be replaced by a pair of 500 shaft horsepower six cylinder four cycle McIntosh-Seymour direct reversible marine engines. The boat will enter service early in 1921.

The motorships *Astmacco III* and *IV*, which have been acquired from the Shipping Board by the Astoria Mahogany Company, New York, were originally built by the Manitowoc Shipbuilding Company, Manitowoc, Wis., and equipped with two 340 shaft horsepower two cycle hot bulb engines of the Bolinder type, but the guaranteed speed of 9 knots has not been obtained and so the owners have decided to recondition the ships with a set of Diesel engines throughout so as to enable them to run at a speed of at least 10 knots. For this reason both of these boats are to be fitted out each with a set of two McIntosh-Seymour four cycle direct reversible marine Diesel engines of 500 horsepower. These vessels are scheduled to enter service again as full powered motorships at an early date.

The New London Ship & Engine Company, Groton, Conn., has under reconstruction for their own account several old torpedo boats from the United States Navy which may be converted to passenger motorships in the coastwise trade. Each will be equipped with two Nelseco engines.

The Staten Island Shipbuilding Company, New York, has

been entrusted with the reconditioning of five auxiliary schooners of the *Starlite* type to full-powered motorships retaining the actual power plant consisting of two 340 shaft horsepower Bolinder engines.

Diesel Engine Builders

Among the American firms that are actually engaged in building marine Diesel engines are the following:

The Busch-Sulzer Diesel Engine Company, of St. Louis, Mo., has acquired the old American Diesel Engine Company, which was founded in 1898 and which was exclusive owner of all the original Diesel patents and rights for the United States. In 1911 the Busch-Sulzer Company was formed, which now owns all the patents of the former company, and, in addition, is exclusive licensee of the Sulzer Brothers, of Winterthur, Switzerland, for their four cycle and two cycle stationary and marine Diesel engines.

During the war this firm was very heavily engaged in the construction of submarine engines for the United States Navy, building engines ranging in capacity from 350 to 900 shaft horsepower of the four cycle as well as of the two cycle type. Recently this firm has built and had under a 30 days' test their first 750-horsepower two cycle marine type engine and are prepared to take future orders for any size of engines up to 2,000 horsepower.

The design of the Busch-Sulzer engines differs very little from the original Sulzer type and only such modifications have been made as to comply with American shop practice.

The New London Ship & Engine Company, Groton, Conn., was organized in 1911 and owns the M. A. N. patents for two cycle as well as for four cycle engines, but in spite of owning the rights to build one of the most successful European Diesel engines, this company has found it better to develop a type of its own and has brought out a Diesel engine under the name of Nelseco which is very different from the original German type. This firm was also very heavily engaged in war work for the United States Navy, as their engines, being of the high speed type, are exclusively used in submarines.

At the present time it appears that this company, which is affiliated with the Submarine Boat Corporation, will enter the merchant marine field and develop a two cycle double acting marine Diesel engine of about 1,250 shaft horsepower. This company is also a strong advocate of the Diesel electric drive.

McIntosh-Seymour Leads in Merchant Work

The McIntosh-Seymour Corporation, Auburn, N. Y., has the rights of the Swedish Polar engine built by the Swedish Atlas Diesel Engine Company, of Stockholm. This firm has also developed its own type of Diesel engine based on the Polar experience, but is exclusively building four cycle engines suitable for merchant marine purposes. This firm has shown the greatest activity in the merchant marine field and has more ships afloat equipped with Diesel engines than all the other companies in this country combined. Up to a short time ago they had been building only a trunk piston type engine, and in connection with the Shipping Board have developed a slow speed heavy duty merchant marine type of a capacity in six cylinders of 900 shaft horsepower running at a speed of 125 to 135 revolutions per minute. A 30 days' test of the first engine has apparently given satisfactory results, and it is rumored that twenty such engines have been ordered through the United States Shipping Board by the Pacific Coast Steamship Company for a fleet of ten motorships of about 6,000 to 7,000 tons. Also this company is prepared to supply engines up to 5,000 shaft horsepower as required in 10,000-ton ships at a speed of 11 to 12 knots.

The William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., has acquired the Burmeister & Wain license for the United States and has under construction for the account of the American-Hawaiian Line of the United American Lines two sets consisting of four engines of 1,750 shaft horsepower for two 11,500-ton boats. These engines will be similar in every respect to those acquired by the Shipping Board some years ago direct from Burmeister & Wain and used in the United States Shipping Board's only motorship, the *William Penn,* which shortly will enter service in competition with the first electric driven cargo carrier *Eclipse* and used in the Far East service.

The Worthington Pump & Machinery Corporation, of New York, has for a long time been building horizontal stationary Diesel engines after the Koerting design which have been used mostly for pipe line work. During the war this firm developed a merchant marine Diesel engine similar to the Burmeister & Wain type for their own account. The first engine of this type has been put through a 30 days' full load test with apparently good results.

New Bethlehem-West Engine

The Bethlehem Shipbuilding Corporation, Bethlehem, Pa., has developed a two cycle engine type of its own, taking as a model the M. A. N. engines of the United States supply ship *Maumee* built some five years ago at the Brooklyn Navy Yard. This first Bethlehem engine is of the two cycle type with valve in head scavenging and develops a capacity of 2,500 shaft horsepower in six cylinders at a speed of around 100 revolutions per minute. This first engine has been installed in the ore carrier *Cubore* of the Ore Steamship Company, of New York, and the results obtained during the first trips of the *Cubore* were so satisfactory that the Ore Steamship Company has ordered four twin screw ships of 20,000 tons each to be equipped with a set of 2,500 shaft horsepower engines.

The James Craig Engine and Machine Works, Jersey City, N. J., has for many years been building a four cycle Diesel engine of its own design which has given in many instances very good results in yachts and service boats. Several units have been installed also in submarines of the United States Navy. This engine is of the column frame type with auxiliary exhaust valves at the end of the stroke in each cylinder, which arrangement should permit the use of very heavy grade oil, such as Mexican and Californian oils, both of which contain heavy percentages of either asphalt or sulphur. This firm has now under construction a 1,500 to 2,000 shaft horsepower six cylinder marine Diesel engine for the account of the Submarine Boat Corporation and it appears that this engine will be ready in a short time for installation in a boat of the Submarine Boat Corporation.

The Skandia Pacific Oil Engine Company, of San Francisco, Cal., is connected with the Swedish Skandia Engine Company, and up to a few years ago was engaged in the building of the Skandia hot bulb engine. About three years ago a Werkspoor license was acquired for the building of the Werkspoor four cycle marine Diesel engines and the company has developed and built under the supervision of the United States Shipping Board a set of two 825-horsepower six cylinder Werkspoor-Skandia marine Diesel engines. This type is quite a departure from the original Werkspoor column frame type and makes very extensive use of cast iron framing, which insures much greater steadiness on board ship. The company has orders on hand for several motorships for the Standard Oil Company.

The Winton Engine Company, Cleveland, Ohio, has developed its own type of high speed marine Diesel engines of the trunk piston type, basing its design on its large experience accumulated during many years of building of heavy duty gasoline marine motors. The engines are built up to 450 horsepower in eight cylinders with a speed up to 250 revolutions per minute. A number of boats, full powered cargo carriers, as well as two yachts, which are propelled by

Diesel electric drive, have been equipped with this type of propelling machinery.

The Nordberg Manufacturing Company, Milwaukee, Wis., is the licensee of Carel Freres, of Ghent, Belgium, for the Carel two cycle type stationary and marine engine. Up to the present time this firm has not been engaged in marine work and is only building engines for stationary purposes in the mining districts of the United States.

The Dow Pump & Engine Company, Alameda, Cal., has for several years built Diesel engines for stationary and marine purposes based on an English design and has several installations of 600 horsepower or more in operation on board ships with apparently good service.

The Manitowoc Shipbuilding Corporation, Manitowoc, Wis., about two years ago purchased the license of the Franco Tosi Company, of Legnano, Italy, but up to the present time has done very little in actual work, having built only one experimental 120-horsepower electric generating set which for several months has been in actual operation with very good results. This company has developed its own design of marine engine based on the Tosi experience and will begin in a very short time experimental work on two cycle single acting as well as double acting direct reversible marine engines.

The United Engineering Company, San Francisco, Cal., is also licensed to build the Franco Tosi marine Diesel engine on the Pacific coast, but up to the present time has done very little in actual Diesel engine work.

Solid Injection Type Diesel Engines

The firms who are building the solid injection type of Diesel engine are as follows:

The De LaVergne Machine Company, of New York, has for many years built a Diesel engine of its own design and a semi-Diesel engine of the Franchetti type. Lately it has built and tested out a vertical four cylinder solid injection type marine Diesel engine with very good results.

The Ingersoll-Rand Company, of New York, has taken over the rights of the Price Engine Company, of New York, and is prepared to supply Price engines in capacities up to 2,000 horsepower.

The Opposed Piston Oil Engine Company, of New York, has been formed to take over the old American Junkers Engine Company to build and grant licenses in this country for the Junkers type Diesel engine, which has been built in England by Doxford, of Sunderland, for many years and of which English company the Opposed Piston Oil Engine Company is also exclusive licensee in this country.

Firms Considering the Building of Motorships

Other companies who own licenses to build Diesel engines are the New York Shipbuilding Corporation, Camden, N. J., and the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., both of which have Werkspoor licenses. On account of urgent navy and merchant marine work no Diesel engine building has been undertaken by either of these firms, but it is probable that later on both companies will take up the construction of Diesel-engined motorships. In addition, the following firms are considering the building of motorships:

The Federal Shipbuilding Company, of Kearney, N. J.; the Moore Shipbuilding Company, Oakland, Cal.; the Long Beach Shipbuilding Company, Long Beach, Cal., which is on the point of concluding a license agreement to build at its own yard two cycle marine engines up to 1,000 horsepower per unit in four cylinders; the Great Lakes Engineering Company, Detroit, Mich.; the Ames Shipbuilding & Dry Dock Company, Seattle, Wash; and the Bath Iron Works, Bath, Me.

The Westinghouse Electric & Manufacturing Company is considering the building of Diesel engines in connection with electric generating sets for Diesel electric drive as well as for auxiliary purposes on board ships. The Ford Motor Company, Detroit, Mich., in connection with the Hooven, Owens, Rentschler Company, Hamilton, Ohio, is considering building Diesel engines for marine and stationary purposes. The Seattle Engineering Company, Seattle, Wash., has built an experimental engine of the four cycle type of its own design. The W. & A. Fletcher Company, Hoboken, N. J., is building a hot bulb engine of its own design for experimental purposes, and the Sperry Gyroscope Company, Brooklyn, N. Y., an experimental compound Diesel engine consisting of two high pressure four cycle cylinders and one low pressure cylinder working on the two cycle principle.

Merchant Marine of France

M. LE TROCQUER, M. Francois Marsal and M. Albert Sarraut, ministers respectively of public works, finance and the colonies of France, and M. Bignon and Thoumyre, under-secretaries of state for the mercantile marine and food supply, met on December 4 to draft a bill providing for the sale of the French national merchant fleet and the establishment of shipping lines with the colonies. The committee will be assisted by a technical commission to carry out the sale.

The ministers also considered modifications in the bill embodying a programme of merchant ship construction which has already been adopted by the Chamber of Deputies and is now before the Senate. The measure provides for an expenditure of over 1,000,000,000 francs (approximately $60,000,000 at the present rate of exchange), while the new programme provides for expenditures amounting to 300,000,000 francs (approximately $18,000,000 at the present rate of exchange) for building liners, 250,000,000 francs (approximately $15,000,000) for building colliers already ordered by the Ministry of Industrial Reconstruction and for the payment of shipbuilding bounties already sanctioned.

The American Marine Insurance Syndicates

(*Concluded from page* 41.)

The headquarters of the Middle Atlantic district have been established in the Stewart building at Baltimore and include all ports from the Delaware River to Charleston. The headquarters of the East Gulf district are in the Orm building at New Orleans, with jurisdiction over Mobile and New Orleans and the headquarters of the West Gulf district are in Galveston, with jurisdiction over the ports of Orange, Beaumont, Houston and Galveston.

An organization on the Pacific coast will soon be established, and as soon as this is completed attention will be directed abroad and the first agency will probably be planted in England. From this point agencies will be appointed throughout Europe. After this agencies will be established in the Orient and South America.

Merchant Marine Convention.—The annual convention of the National Merchant Marine Association will be held at the Washington Hotel, Washington, D. C., on January 20 and 21. Included in the list of speakers at this meeting are leaders in shipping, railroad, export and import companies, agriculture, manufacturing, Government departments and prominent members of Congress. The Mississippi Valley Association and the South Atlantic Association have arranged to hold meetings on January 19 and 20 and will join with the National Merchant Marine Association in a joint programme for the promotion of United States shipping.

A Review of Motorship and Marine Diesel Engine Building in Europe

BY OUR SPECIAL LONDON CORRESPONDENT

The year 1920 has marked a revolution in the development of the motorship in Europe. It would seem that, almost without exception, shipowners have become converted to a belief in the advantages of the internal combustion engined vessel, and so strongly do some of them hold to this opinion that orders have been placed for batches of motor craft, in some cases contracts for as many as ten new ships being fixed. The position can best be explained, so far as Great Britain is concerned, from a statement of the fact that there are now thirteen of the leading shipbuilding and marine engineering concerns in the United Kingdom actually building marine oil engines on a commercial scale for installation in motorships, while four more are constructing their first experimental engine. These seventeen firms represent the cream of the shipbuilding industry, and those concerns which have not yet interested themselves in oil engine construction hold for the most part a second rate position.

DURING the year about twenty large motorships have been completed and the orders in hand in European yards now amount to between 180 and 190 ships, varying from vessels of 14,000 tons deadweight capacity to craft of 3,500 tons. There are, of course, many more motor vessels of smaller size being built, but these do not come within the scope of this review. The ships on order probably represent a deadweight carrying capacity of somewhere in the neighborhood of 1,500,000 tons, and as the majority of the contracts are for completion before the end of 1922, it will be seen that within two years there will be a vast fleet of European motor vessels trading throughout the whole world.

Leading Shipowners Building Motorships

In Great Britain twelve of the leading shipowners, including the British India Steam Navigation Company, the Pacific Steam Navigation Company, the Royal Mail Steam Packet Company, the Glen Line, the Bibby Line, the Brocklebank Line, and Lamport and Holt, are having motor vessels built and the same tendency of the chief shipowning firms in continental countries is to be noted. For instance, in Denmark the East Asiatic Company, in Sweden the Transatlantic Company and the North Star Company, in Norway the Thoresen Line and the Olsen Line, in Holland the Royal Netherlands Steamship Company, in France the Chargeurs Reunis, and in Italy the Societa Nazionale di Navigazione, of Genoa, all have motorships under construction, and this is mentioned to indicate that few, if any, of the more important shipowning firms in Europe deem it advisable to remain outside this new movement.

In addition to the commercial success which has been achieved during the past year, there has been a marked technical development, the influence of which will probably be more fully felt in the course of a year or two. The size of motorships has increased up to 14,000 tons deadweight carrying capacity, while still larger craft are in contemplation and the power of individual oil engines has risen to 3,200 horsepower, not merely as a specialized type but as a standard design of which very large numbers are being built.

Three entirely new types of marine Diesel engine have

Fig. 1.—The 10,000-Ton Motorship *Yngaren* After Launching. She is the First of the Doxford Standard Motorships

been built in Great Britain and their trials carried out, these being the Doxford and Cammell Laird two stroke engines and the four cycle motor developed by the North British Diesel Engine Works. In addition, the first experimental Still combined steam and oil engine, designed for commercial use, has been completed and tests made, and it will therefore be gathered that builders are not relying solely upon established models but are breaking out along new lines with the object of producing engines of higher efficiency or with which some other advantage may be gained such as the possibility of constructing them in very large powers. So far have developments gone that manufacturers of four cycle engines of the Burmeister and Wain type are now prepared to build them in sizes of 4,000 horsepower, while builders of the two cycle engines of the Sulzer design are willing to manufacture 6,000-horsepower sets under any reasonable guarantee. On the Clyde, Messrs. John Brown & Company, builders of the *Lusitania* and of many transatlantic liners, are experimenting with the new Cammellaird-Fullagar engine, the object in view being its employment in powers up to 10,000 or 15,000 horsepower in large or fast transatlantic liners.

Two Stroke versus Four Stroke Engines

Although probably in four-fifths of the motorships now in service and in 75 percent of those under construction, four cycle machinery is installed; nevertheless, British engineers are by no means unanimous in their belief that the greatest progress in the future will be with this type of machinery. On the contrary, there is a very general opinion that, especially for the larger sizes, the two cycle Diesel motor will prove itself more satisfactory and will possess advantages that will render it an extremely strong competitor to the engine operating on the four cycle principle. Hence we see that the three most interesting types of motor developed during 1920, namely, the Cammellaird-Fullagar, the Doxford and the Still engines, are all two stroke machines and, moreover, while in Great Britain there are six manufacturers of marine oil engines of the four stroke type, no fewer than eleven have pinned their faith to the two stroke set.

Even the double acting two cycle engine has its advocates and the North British Diesel Engine Works, which is now building four cycle engines, is experimenting with a double acting two stroke motor with a view to its ultimate adoption in place of the existing type.

It is interesting to analyze the reasons which, it is claimed, render the two cycle engine more advantageous. The fuel consumption is admittedly higher, but only to the extent of about 7 or 8 percent, but builders who have adopted this design claim that the cost of construction is lower, the weight and space occupied are smaller and the cost of construction is naturally reduced.

New Types of Diesel Engines

There is another point in which the two stroke engine is showing its superiority. It is becoming increasingly difficult to obtain the better grades of fuel oil which have for the most part hitherto been utilized in Diesel engines. The future type of marine oil engine must therefore be designed so as to be capable of burning any grade of oil, even Mexican fuel oil. The main obstacle to its satisfactory utilization is its deleterious effect upon valves, especially on the exhaust valves. In the modern type of two cycle engine there are no valves other than those for the starting air and fuel injection. Scavenging air is admitted through ports, while a further series of ports is provided for the discharge of the exhaust gases. Provided, therefore, that combustion is good, there is no reason why almost any quality of oil should not be used satisfactorily in two stroke engines, more particularly in those of the opposed piston type in which the scavenging air sweeps right through the cylinder from bottom to top.

Of the new engines the Cammellaird-Fullagar engine has already been described and illustrated in these pages and need not be dealt with at length. It might be recalled, however, that this engine was developed by the late Mr. H. Fullagar about 1912 and was only taken up in earnest by Cammell Laird & Company after the armistice. The first set was placed in the 500-ton coaster *Fullagar* in the early summer of 1920, and since that time the vessel has been in regular operation along the coasts of Great Britain covering about 10,000 miles, the results having proved that at any rate this particular size of the engine fulfilled all the builders' expectations.

It will be remembered that it is an opposed piston type built with unit pairs of cylinders, the crossheads of the top piston of one cylinder being joined by diagonal rods to the crossheads of the bottom adjacent cylinder. The fuel consumption has proved fairly good, being about 0.42 pound per brake horsepower hour and the results were sufficiently good to induce such well-known firms as Messrs. John Brown & Company, Messrs. Dunsmuir Jackson & Company and Messrs. David Rowan & Company, Limited, as well as a large American shipbuilding concern, to take out licenses for the construction of the Cammellaird-Fullagar type. It should, however, be borne in mind that the power of the engine on which the trials can be carried out is relatively low (being only 500 brake horsepower) and that it will be easier to give a definite opinion regarding the possibilities of the engine when larger sizes have been built. Two sets each of

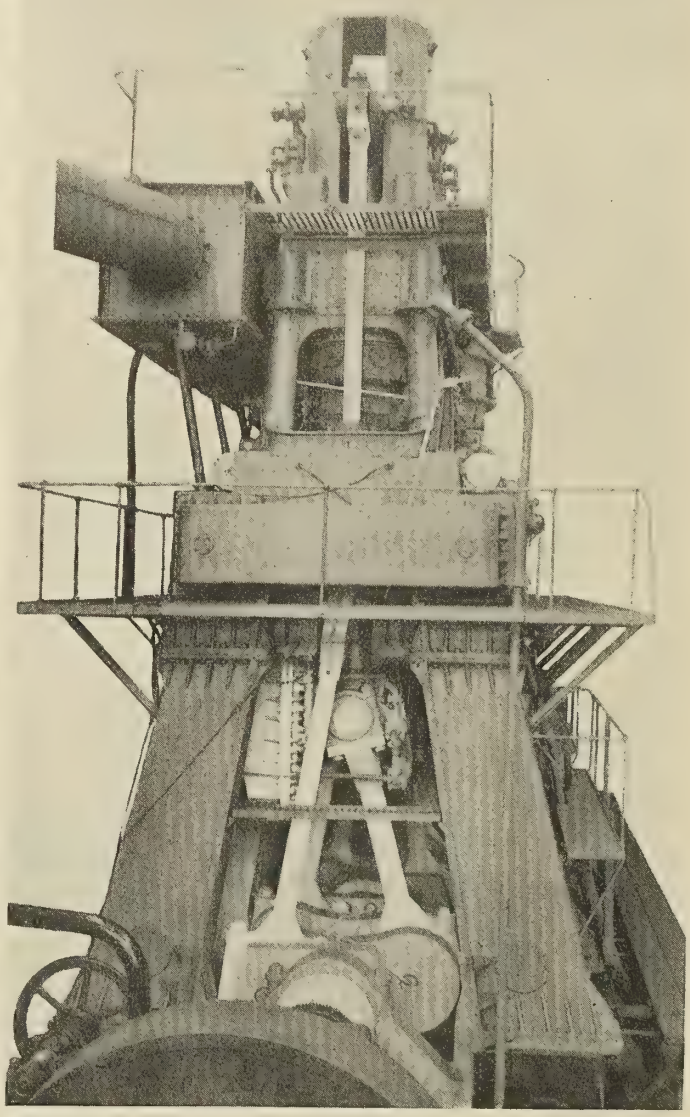


Fig. 2.—End View of 3,000-Horsepower Doxford Oil Engine

1,000 brake horsepower are now practically completed and will shortly be installed in a cargo vessel for the Ellerman Line.

Completion of the First 3,000-Horsepower Doxford Engine

The development of the Doxford Diesel engine was perhaps the most interesting and important feature of oil engine construction in 1920. The builders, Messrs. W. Doxford & Sons, had so completely pinned their faith in this design that they took orders for the manufacture of six standard 3,000-horsepower sets before the first was completed and obviously it would have gone ill with them had they discovered any inherent defects when they were testing out their first motor. However, they have spent about twelve years in experimental and investigation work, so that it cannot be said they are new to the industry.

The new 3,000-horsepower standard Doxford engine, the first set of which is now undergoing its final test in the shop, is also of the opposed piston type. Having accepted this main principle, which was first applied to oil engines by Professor Junkers in Germany, the builders followed on their own ideas and produced an engine unlike any type previously constructed. In one respect it actually has a similarity to the hot bulb motor, for the two opposed pistons working in one cylinder are both provided with plates at the top made of ingot steel, which are maintained constantly at a high temperature and are not cooled by the piston cooling water. The object of this is to enable a lower pressure of compression to be employed, and actually this is only 300 pounds per square inch instead of the usual 500 pounds per square inch with the normal Diesel engine. There is apparently no disadvantage in this arrangement except for the fact that the engine must be heated up by means of steam before it can be started, but this process only takes about half an hour. When the engine is running, the heat that is retained in the piston tops, combined with the heat of compression, is sufficient to provide effective combustion of the fuel, as is indicated by the fact that the Doxford engine will run at a lower minimum speed of revolution than any engine hitherto produced. The normal speed of the 3,000 indicated horsepower set is 77 revolutions per minute, and it can be throttled down to run continuously at about 16 revolutions per minute.

Fuel Injection at 7,000 Pounds per Square Inch

This characteristic of low speed operation is facilitated by the employment of solid injection, which was decided upon by the manufacturers after a long period of investigation on an experimental cylinder. Solid injection is, of course, very unusual in Diesel engines, and the only other builders who adopt the principle are Vickers, who utilize it both for mercantile and submarine engines. In the Doxford motor, however, the pressure employed is very much higher than the Vickers type, the usual figure being in the neighborhood of

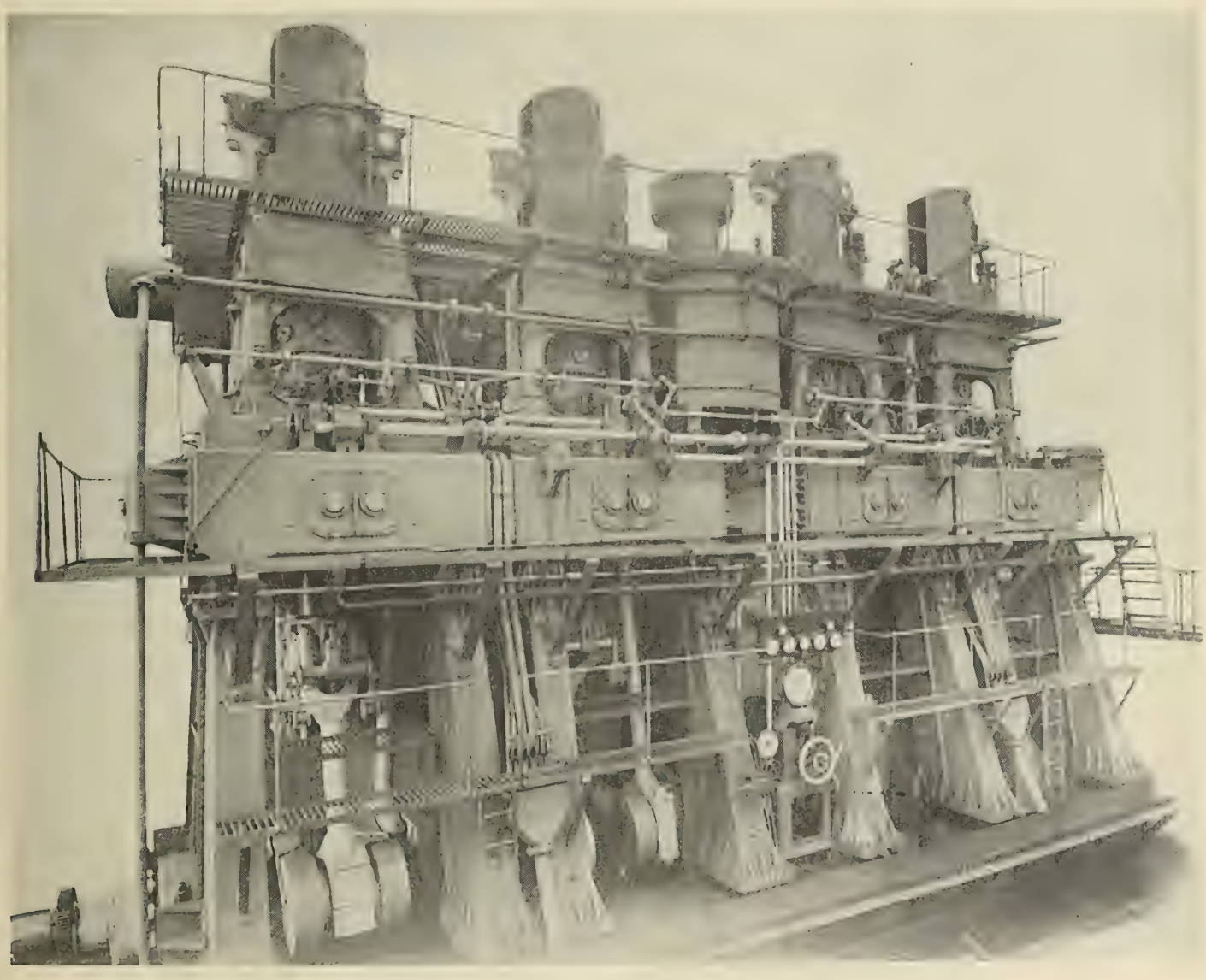


Fig. 3.—3,000-Horsepower Doxford Oil Engine

7,000 to 8,000 pounds per square inch. It is worth noting that this high pressure gives rise to no difficulties whatever, and by utilizing fuel pump without glands even leaks have apparently been entirely eliminated. In order, however, that there may be no possibility of trouble in their first engine, the manufacturers are providing two sets of pumps, one driven directly off the crankshaft of the main motor and the other by an auxiliary steam engine or electric motor, the two sets being interchangeable and both controlled by a small hand wheel at the starting platform.

The scavenging pump is located in the center of the engine, and as this is the only auxiliary driven it is natural that a high mechanical efficiency should be attained. The brake horsepower of this motor is in the neighborhood of 2,700, which is higher than that of any other marine oil engine yet built.

A very compact arrangement is effected by delivering the scavenging air into the cylinders through ports at the bottom via a scavenging trunk which surrounds the cylinder and is supported on the cast iron columns. Similarly, the exhaust gases are discharged through ports at the top of the cylinder into a belt surrounding the cylinder and then into a water cooled silencer at the back. There is a fuel valve at the back and the front of each cylinder, so as to give even admission of fuel, but it may be noted that the fuel pumps at the back are not utilized when going astern, so that only half the power is available in the astern direction. The object of this is to avoid complication of the reversing gear, so that only the camshaft at the front operating the one set of fuel valves needs to be moved when it is required to go astern.

The two camshafts are separately driven and on the one in front of the engine are two cams for each fuel valve and two for each starting valve. When it is desired to go astern all the valve levers are lifted off the cams, the camshaft is moved fore and aft, after which the air starting levers are brought into contact with their cams, admitting compressed air for a few revolutions when the fuel valve levers are brought into action and those for operating the starting valves lifted off the cams. All these operations are carried out by means of the large handwheel at the starting platform, while the movement of the camshaft is effected manually by a lever close to the maneuvering wheel. Variation of speed is obtained by reducing the lift of the fuel valves and at the same time controlling the pressure of the fuel. It is significant that fresh water is used for cooling both the cylinders and the pistons, this being unusual, although the practice of using fresh water for piston cooling is now becoming common and is adopted by Burmeister and Wain and Harland and Wolff in their large engines.

The cylinder dimensions of the Doxford engine are 580 millimeters bore and 1,160 millimeters stroke, giving a moderate piston speed of approximately 600 feet per minute. The fuel consumption appears to be in the neighborhood of 0.42 pound per brake horsepower hour and the engine is run on Mexican oil.

A New Four Stroke Engine

The new engine of the North British Diesel Engine Works, of Glasgow, the first example of which was only completed in December, is of an entirely different type. In the first place it is a four stroke set, the builders having decided that in the first instance there would be less risk attaching to this construction, although they intend at a later date to develop a double acting two cycle motor upon which they are now experimenting. They have standardized an eight cylinder engine of 2,330 indicated horsepower, the adoption of eight cylinders being again to diminish any possibility of trouble by employing cylinder dimensions which had previously been found suitable for four stroke work. The brake horsepower is, however, relatively high, since in the first engine the air compressors are driven by separate high speed Diesel engines. The novelties in the design of this motor include what is commonly termed an entablature construction in which the entablatures supporting the cylinders are carried on steel stanchions which take the whole of the weight and the cast iron columns can therefore be made relatively light.

This design is of some interest in view of the fact that Sulzers, who were one of the originators of the idea, have abandoned it entirely and the framing of their engines consists of the usual cast iron columns. On the other hand, Harland and Wolff have adopted the steel column design, so that there is evidently no unanimity among Diesel engine builders in this direction.

The second novel feature in the North British Diesel Engine Works type of motor is the method of reversing. There is the usual pair of side-by-side cams, one for ahead and one for astern, for actuating each of the valves, but instead of lifting the valve levers, as is usual when it is desired to move the camshaft fore and aft for reversal, in this case the whole camshaft is dropped bodily away from the rollers of the valve levers while the movement is made, after which it is brought up again into contact with the cams.

The Conversion of Steamers to Motorships

One of the most significant events in the shipping world in 1920 was the commencement made of the conversion of existing steamers to motor vessels. In the opinion of many shipowners, who are finding some difficulty in operating their ships at a profit in view of the high price of coal, the conversion of tramp steamers to motor craft offers the only solution of their difficulty. Immense interest was therefore taken in the first conversion carried out on a Swedish ship owned by the Banck Line, a 5,000-ton vessel with machinery of about 1,200 horsepower. The steam engine which was displaced was an ordinary triple expansion set, and in its stead a 1,200-horsepower Sulzer two cycle motor with four cylinders was fitted. It is not known what was the cost of conversion, but it was carried out at Hamburg and the amount paid was certainly less than would have been the case had the work been done at a British yard. The saving effected, however, was sufficient to make a marked impression upon the shipowning community, for instead of using 20 tons of coal at an average price of about £7 or £8 per ton, the vessel (named the *Augusta*) now consumes only four tons of oil per day costing about £11 per ton.

There is only one obstacle which prevents a general conversion of a large portion of the existing European mercantile fleet to motor power. This lies in the high cost of work in the shipyards at the present time, particularly work of this nature, for which the men obtain higher rates than for new ships. The Transatlantic Steamship Company, of Gothenburg, had decided to commence the conversion of all their steamers to motor vessels (totalling about 25) and ordered an engine to be fitted in the first craft on which such a conversion was to be carried out. They found, however, that the expense of the work (and not of the engine) was so prohibitive that they decided to wait until there was something of a slump in shipbuilding, when they consider that prices for such work will be considerably reduced, and when that occurs they will probably transform all their steamers into motorships.

Motor Passenger Liners

For the first time the problem of building motor passenger liners reached a practical stage in 1920. Hitherto this has been looked upon as a doubtful proposition, but early in the year the British India Steam Navigation Company, one of the largest shipping concerns in the world, decided to build three motor passenger liners for their Eastern trade. The first of these will be completed early in the near year and, although not the largest type of liner, it will afford an excellent opportunity of judging the possibilities of much bigger

Fig. 4.—New 7,000-Ton Motorship *Tosca*, Owned by Winge & Company, Christiania. The First of Four Vessels for the Same Owners. Fitted With Two 1,400-Horsepower Werkspoor Oil Engines

ships. The new ships will be mixed cargo and passenger ships carrying about 10,000 tons of cargo and 150 passengers.

More ambitious is the order placed by an Italian firm with the Ansaldo San Giorgio Company for five motor passenger liners in which machinery of 8,000 brake horsepower will be installed, while the Brostrom Line, of Stockholm, has contracted for a transatlantic motor passenger liner to be built in Scandinavia, larger than any of the vessels now contemplated. Moreover, the Elder Dempster Line, of Liverpool, has converted an existing motorship, the *Glenapp*, into a passenger vessel to trade between Liverpool and the West Coast of Africa. This ship, now named the *Aba* and fitted with Diesel machinery of 6,000 horsepower, will sail on her maiden voyage as a passenger craft early in 1921.

Prospects for 1921

It is difficult to speak in measured terms of the prospects for 1921, which cannot fail to mark a record year in motorship development. The number of motor vessels now on order is given above, and of these it is estimated that nearly 100 will be completed during the coming year, with a total deadweight carrying capacity of between 750,000 and 800,000 tons. It must be remembered, too, that with each month the capacity of European shipyards for turning out motorships is increasing, for practically all the large shipbuilding firms in Great Britain are increasing their oil engine shops, which hitherto have been too limited in size and equipment to meet all the demands that have been made upon them. The large concerns are spending hundreds of thousands of pounds upon new equipment, and in many cases are converting what were originally boiler and steam engine shops into the most up-to-date works for the sole manufacture of oil engines. It has become fully recognized that this is the only method by which marine oil engine manufacture can be carried out to advantage, combining it with thorough standardization, so that the tendency is to build standard motor vessels equipped with machinery of standard size and construction. The results of these additions to existing workshops will be to render the manufacturers throughout Europe capable of an output two, three or even four times as great as in 1920.

The table given below shows details of a few of the motorships now in course of construction for some of the larger shipping concerns, and perhaps one of the most significant facts in connection with the popularity of the motorship is that whereas a large number of orders for steamers have been cancelled during the past few months there does not seem to have been a single instance of a contract for a motor vessel being abandoned.

Shipping Company	Number of Ships	Deadweight Tonnage	Indicated Horsepower
Glen Line, London	5	14,000	6,400
Glen Line, London	5	10,500	3,600
Pacific Steam Navigation Company, Liverpool	3	10,000	3,600
Pacific Steam Navigation Company, Liverpool	3	12,000	4,500
British India Steam Navigation Company, London	4	10,500	4,600
Tankers, Limited, Liverpool	4	10,500	3,500
Transatlantic Company, Gothenburg	3	10,000	3,000
Transatlantic Company, Gothenburg	7	9,400	3,100
East Asiatic Company, Copenhagen	18	9,400 to 14,000	3,000 to 6,400
Winge & Company, Christiania	4	6,500	2,800
Societa Nazionale di Navigazione, Genoa	4	12,000	8,000
Grangesberg Ore Company, Gothenburg	4	8,000	3,000

As an indication of the strength of the Diesel engine movement in Great Britain, the following list of firms now actively engaged in the production of motorships may be of interest:

	Name of Shipbuilder	Standard Engines Built
1.	Armstrong Whitworth & Company	1,700 indicated horsepower (two cycle)
2.	John Brown & Company	
3.	William Beardmore & Company	1,200 indicated horsepower
4.	Cammell Laird & Company	1,000 brake horsepower
5.	W. Doxford & Sons	3,000 indicated horsepower
6.	Dunsmuir & Jackson	
7.	Fairfield Shipbuilding and Engineering Company	
8.	Harland & Wolff	1,800 and 3,200 indicated horsepower
9.	Hawthorn Leslie & Company	1,400 indicated horsepower
10.	North Eastern Marine Engineering Company	1,400 indicated horsepower
11.	North British Diesel Engine Works	2,330 indicated horsepower
12.	David Rowan & Company	
13.	Swan Hunter & Wigham Richardson	1,500 brake horsepower
14.	Alexander Stephen & Company	1,700 brake horsepower
15.	Scott Shipbuilding and Engineering Company	2,000 brake horsepower
16.	J. S. White & Company	1,500 brake horsepower
17.	Vickers, Ltd.	1,270 brake horsepower

Of these, Messrs. Cammell Laird & Company, David Rowan & Company, John Brown & Company, and Dunsmuir and Jackson are building the Cammellaird-Fullagar engine; Hawthorn Leslie & Company and the North Eastern Engineering Company are constructing the Werkspoor four cycle type; Armstrong Whitworth & Company and Alexander

Stephen & Company are building the Sulzer engine; Scotts Shipbuilding and Engineering Company the Still combined steam and oil engine; Harland and Wolff the Burmeister and Wain type; Beardmores the Tosi design; Swan Hunter and Wigham Richardson the Neptune Polar type; while Vickers, Doxfords, Whites and the North British Diesel Engine Company are all manufacturing engines to their own design.

Among other firms which have either obtained licenses or will shortly acquire them are William Denny Brothers, of Dumbarton; Yarrows, of Scotstoun, on the Clyde; the Wallsend Shipbuilding and Engineering Company, and Palmers Shipbuilding and Engineering Company. On the Continent the same degree of activity is being shown, and in Denmark there are three firms mainly or exclusively engaged upon motorship construction, in Sweden three, in France two, Holland two, Italy two, Norway one, and Switzerland one, in the latter case only engines being manufactured, as the Sulzer firm is not engaged in shipbuilding.

Arc Welded Ships

BY O. H. ESCHHOLZ*

Arc welding is no longer a novel process. Since the original patent of Slavianoff in 1887 it has been conservatively developed, until in many industries this form of welding has achieved merited recognition as an essential means for the fabrication of steel structures. In shipyards the metallic electrode arc is definitely established as an important tool for the repair of broken parts, replacement of worn and corroded members, securing oil- or watertight structures, and the production of non-strength joints. Some of the problems involved in the application of arc welding to shipyard work are outlined briefly in this article.

EXPERIENCE with welding in the shipyards has led to the arc welding of the Geary launch in 1915, the Newburgh barge, 1917, the Richborough barge, 1918, Norfolk towing target, 1920, and the coaster *Fullagar,* 1920. The performance of these craft under adverse conditions has clearly demonstrated the practicability of the small welded ship. The attitude of the welding research sub-committee of the welding committee of the United States Shipping Board in 1918 was that "there are no outstanding technical questions requiring solution in order to proceed at once to the construction of welded ships."

Fig. 1.—Appearance of Metallic Electrode Welding Arc. The Molten End of the Wire Electrode is Shown Assuming a Globular Shape Preliminary to Being Released and Deposited on Plate

Advantages of Arc Welding

The advantages derived by arc welding usually cited are:

(1) With the elimination of marking off, drilling or punching, countersinking and calking, a considerable economy in time and labor can be effected.

(2) By the reduction in width of laps and size of butt straps a saving of from 5 to 10 percent of material can be effected.

(3) Welded joints can be made to withstand greater stresses than similar riveted joints, and can be made equal in strength to the ship plating.

(4) Once the practice is standard a reduction in the weight of the shell plating will be possible without reducing the safety factor.

(5) A welded joint is oil- and watertight up to its breaking point, whereas riveted and calked joints are liable to leak badly at as low as 25 percent of their ultimate strength.

It is generally recognized that arc welding has come to stay in the shipyard. As an indication of the faith of the English builders in the future of the welded ship, the following list of projected vessels is of interest. In Lloyds Annual Report for the last year reference is made to a design which had been submitted and approved for the welded construction of a longitudinally framed vessel 303 feet long. Designs have been prepared by one of Vicker's associated companies for the welded construction of a large number of self-propelled barges, 125 feet long, 16 feet beam, 320 tons displacement, in France. The Forth Ship Building Company at Alloa has prepared designs for the construction of a welded tanker. At Millford Haven arc welding is being used extensively to convert an ordinary cargo vessel into an oil tank boat. The coaster *Fullagar,* recently launched by Cammell Laird & Company, is an experiment with the view of employing similar welded construction in larger vessels.

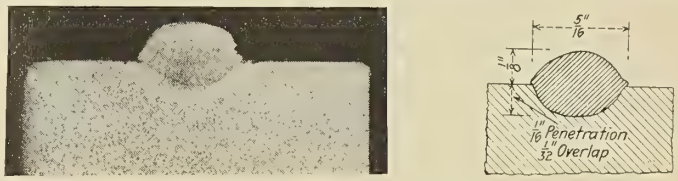


Fig. 2.—Etched Section Through a Single Layer of Metal Deposited (Welded) on Plate. Note the Zone of Fusion, Crystal Structure Change, Penetration and Overlap

Welding Activities Proposed

An established process, such as riveting, obviously yields ground slowly to one less known. This inertia can be overcome by the liberal dissemination of knowledge concerning the newer process and experience with its application. In this connection it is important to note that at a recent meeting of the American Bureau of Welding some of the major activities proposed for the ensuing year were:

(1) Development of a standard training course for the education of supervisors and arc manipulators.

(2) Standardization of weld inspection and test methods.

(3) Standardization of welding procedure for various applications.

(4) Compilation of available data concerning physical properties and cost of welded members.

The problem of the all welded ship is essentially that of educating the design and construction staff in the characteristics and use of the process. Its employment on a large scale for the joining of strength members requires the building up of a welding organization comprising superintendents,

* Material and process engineering department, Westinghouse Electric and Manufacturing Company, East Pittsburg, Pa.; member of American Bureau of Welding.

foremen and operators who are expert and conscientious in the use of the process before cautious engineers are justified in specifying the extensive substitution of welding for riveting.

FEEDING MATERIALS AND ASSEMBLING METHODS

A problem second in importance only to that of training* is the development of materials feeding procedure and assembling methods that will assure a minimum interruption to the operator and negligible residual strains in the welded area caused by the contraction of the deposited metal. Most of the larger welded structures such as frames and platings

Fig. 3.—Etched Section, Showing Fusion Pattern on Building Up a Heavy Deposit by Layer Deposition. (In Order to Facilitate a Definite Marking of the Fusion Boundaries Two Types of Electrodes Were Used)

in the experimental vessels were assembled to form lap or butt strap joints by means of service bolts and tack welds. As this method detracts somewhat from the advantages to be derived in welding, various expedients are being developed that will accomplish the same purpose without the necessity of perforating the plates. In this connection it is desirable to point out that the welding conference committee of the American Welding Society is compiling the experience of numerous manufacturers in the construction of welded pressure vessels and a second committee is engaged in the design of a large welded storage tank. The experience that will be available in the coming year from the welding of such plate structures will be applicable in numerous ways to shipbuilding.

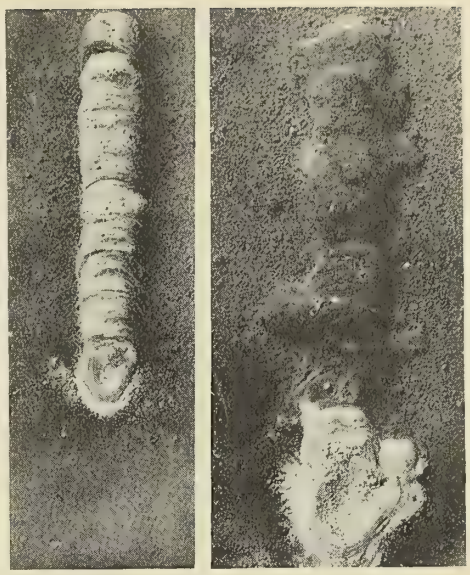


Fig. 4.—Surface View of Layers Deposited When Holding a Short Arc, Left, and a Long Arc, Right. Note Difference in Contour, Density and Distribution of Oxide

It is frequently stated that the characteristics of a weld are dependent to a large degree upon the "personal equation" of the welder. An analysis of the arc welding process shows that it is peculiarly susceptible to control, a characteristic that it possesses in common with electrical apparatus and electrical processes. The development of a control to minimize the human variability factors and by fixing the arc current, arc length, direction of deposition, and materials used is merely a matter of an adequate welding organization.

VISUAL EXAMINATION OF DEPOSITED METAL

With the increased dispersion of a technical knowledge of

* Training of Arc Welder, O. H. Eschholz, *Electrical World*, September 27, October 4, 1919. Overhead Arc Welding, O. H. Eschholz, *Power*, November 16, 1920.

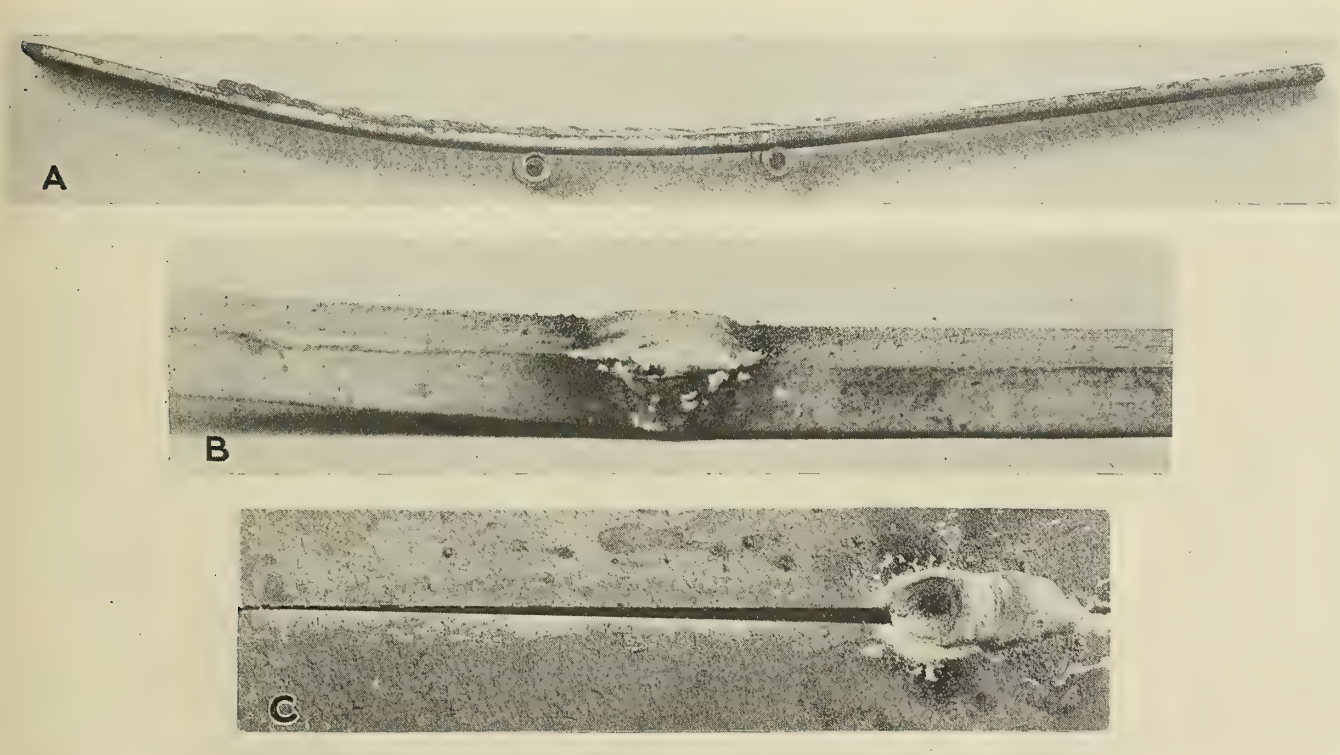


Fig. 5.—Plate Movement Caused by Contraction of Hot Deposited Metal Upon Cooling. A, Longitudinal Contraction in Layer. B, Transverse Contraction in Metal. C, Example of Stresses Produced by Contraction Drawing Plates Together Initially Separated ⅛ Inch

the process the significance of visual* examination of deposited metal will be obvious. The salient characteristics of fusion—overlap, penetration, oxide distribution, crater depth—are clearly revealed to the trained eye and give a quite satisfactory indication of the workmanship and characteristics of the weld. Electrical and magnetic inspection methods are now in an advanced stage of development; these, when available, will give a further check on the degree of fusion and soundness of the deposited metal. It is necessary to point out, however, that none of these methods gives a measure of the value or distribution of residual stresses. As such stresses are determined by the method of assembly and design of joint, their evaluation falls within the province of an engineer or designer.

Cost of Welding

The cost of application is the final criterion of the process. Two important factors that are susceptible of considerable reduction are cost of electrodes and welder's time. The practice of the British ship welders has been to employ special covered electrodes. The manufacturers of these electrodes have been largely responsible for the impetus given to ship welding in England, a number of them having secured Lloyd's approval for the application of arc welding to a large number of parts, as well as for the design and supervision of the welded Richborough barge and the 425-ton coaster *Fullagar*. The cost of such electrodes, however, places quite a burden on welding. With the present increased scientific knowledge of the characteristics of the cheaper bare electrodes, it should be possible to obtain for them nearly as broad a classification.

With the use of a given electrode, currnt density and a short arc length, the speed of metal deposition is a direct function of the arc welding current. This fact should be clearly recognized by designers in order that wherever feasible the joint will be given a high thermal capacity, thereby permitting the use of a high welding current and a resulting high welding speed. There is already a tendency to take advantage of this characteristic of arc welded joints. A few years ago a value of 125 amperes was considered to be the proper welding current for most work; now many applications employ 175 amperes and the future points to the use, with suitably designed joints, of 225 and 250 amperes.

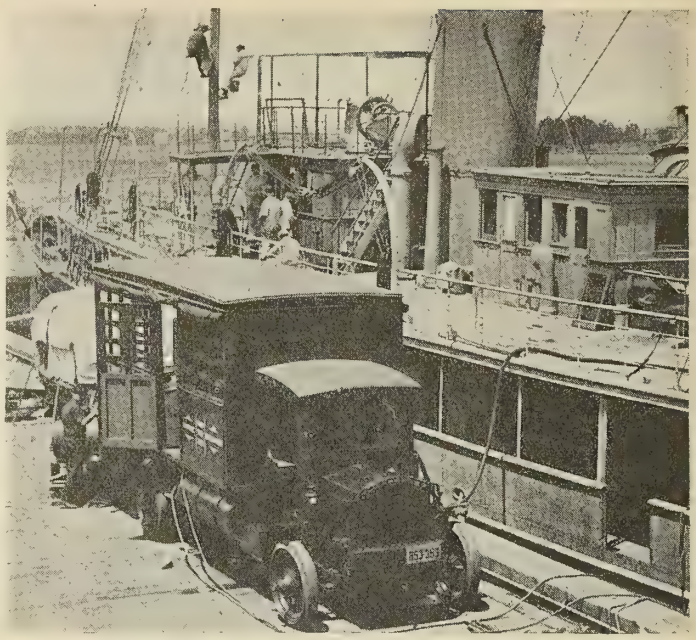
While the all-welded ship is the ultimate goal of welding enthusiasts, it is recognized that its logical development will come only through the cautious displacement of riveting by an organization fully conscious of the merits of the two processes. The welding of non-strength members, not adaptable to inexpensive riveting in the fabricating shops, will occupy the first stage, the welding of superstructures, internal division fittings, deck plates, oil tanks the second stage, and with the availability of adequate process control and inspection methods the process will be extended to the welding of the main strength members composing the frames and shell.

* Fusion in Arc Welding, O. H. Eschholz, American Institute of Electrical Engineers, March, 1919.

Electric Welding Plant Mounted on Motor Truck

MOUNTED on the chassis of a Packard motor truck owned by the United Marine Contracting Company, of New York City, is a complete self-contained, portable electric arc welding outfit for either land or marine work. It is the first and only motor truck arc welding plant in the country and serves as a striking example of the adaptability of the motor truck to an ever-increasing cycle of industrial uses.

Stimulated during the war by the necessity of keeping every available ship in running order, the electric arc welding process for marine transportation purposes was greatly improved. Barges equipped with complete welding plants to facilitate the repair of cracked boilers and broken engine parts that could not be brought to a stationary shop resulted from the energetic efforts to keep warships in commission.



Portable Welding Plant in Operation

The Covic Electric Company, of New York, undertook to meet this need for a portable land outfit by mounting an electric welding apparatus on a motor truck. The object was to serve as economically as possible both the marine and land requirements. Due to its greater mobility, such a machine could travel from job to job much more quickly, cutting down the idle time of the welding plant and crew. The truck also eliminates a towing bill, which is always necessary in the case of the barge, resulting in a considerable saving on each job.

The unit finally developed consists of a Packard heavy duty chassis on which is mounted a large body of special design which gives ample space for the apparatus and for supplies. Directly over the rear axle is the power plant, including an electric generator driven by a 40-horsepower gas-kerosene engine, which produces a direct current of 150 amperes for each welder at 50 volts. The capacity of a machine is two welders.

Welding supplies such as short lengths of welding wire, welding glasses, hammers, etc., are carried in small compartments built on the under side at the rear of the body. A 40-gallon spare fuel tank is provided, as is also a tank for 20 gallons of lubricating oil for all machinery.

In the forward part of the body is mounted a 90-foot air compressor to supply compressed air for the pneumatic hammers and tools which are used in preparing the pieces to be welded and in finishing off the completed weld. This compressor is driven by the Packard motor through a power take-off from the drive shaft. Twenty horsepower is required to operate this machine at 250 revolutions per minute.

A special transmission was designed for this truck to provide for operating the air compressor from the drive shaft. A Morse chain is used to transmit the power from a sprocket on the drive shaft to a sprocket on the compressor. These sprockets provide for a reduction ratio of four to one in order to give the desired 250 revolutions per minute.

The truck is provided with a work bench which has the necessary equipment needed for an emergency. The body is fitted up with electric light, current for which is supplied by the generator. This makes night operation possible and quite safe.

The crew consists of six men—two welders, two chippers, an engineer and his helper.

Progress of Welding in the Shipyards

BY WILLIAM T. BONNER*

The year now closing has witnessed a wonderful development in the ship welding art. We no longer speak of the welder's metallic electrode as the spirit wand with which he performs his magic transformations behind the dazzling arc. Wonderful as they are, we may now behold these operations as they are progressively projected on the screen and study the phenomena of fusing plate to plate as we formerly studied a moving picture of riveting.

CHEMISTRY, metallurgy and photography have combined to show us what constitutes a good weld. How to make them is now an open secret. We have long known, of course, that electrically deposited metal is, primarily, a casting and its characteristics correspond closely to those of any other casting made of similar materials in so far as its tensile strength, ductility and other physical qualities are concerned. To a certain extent, however, it is better than castings made in the ordinary way, since it is free from the contaminating influences of the foundry mold and also the oxidizing effect of the coke fires, and it is expected we shall ultimately learn how to treat our electric welds when made so as to convert them from castings into forgings.

Our 1920 progress in welding has confirmed our previous conclusions about welding in many particulars. Leading engineers are now generally agreed that the short arc of, say, ⅛ inch, with current of 16 to 20 volts across the arc, is preferable to any other. It permits making a thoroughly good weld, absolutely free of porous spots, and it avoids the oxidizing opportunities always present when the molten metal is traversing the path of a long arc.

Advantages of Using Higher Amperage

Both manufacturers and users of welding equipment have also learned the advantage of using higher amperage, especially for work in exposed situations and where the material volume is sufficient to withstand the greater heat impact; 170 to 180 amperes for welding ½-inch plate does not appeal to the operator who wants a job to last, but it ensures a good weld and a quick one when rightly handled and backed up by a machine with ample copper content to absorb all of the shocks due to electrode imperfections and inequalities in the work.

No welding generator should be designed for less than 175 amperes normal rating for shipyard service, unless it be intended exclusively for the shop fabrication of light tank and ventilator work. In fact, the present year has witnessed a decided move in the direction of 250- and 300-ampere plate welding with 3/16-inch and ¼-inch electrodes, although the field for that must be limited to heavy plates and steel castings with extended seam areas.

Were we content to limit our welds to the quality of a good casting, regardless of the efficiency of the fused junction of weld and virgin metal, we might select any combination of wire and amperes which would give us a fusing temperature of approximately 3,200 degrees F., that being the temperature at which steel founders generally expect to obtain the best results. When poured at temperatures higher than 3,200 degrees F., steel castings become brittle and they also show pronounced indications of oxidation. As near as it can be determined, the physical heat of the arc is in the neighborhood of 6,400 degrees to 6,600 degrees F., and were it not for certain modifying conditions our welds would all suffer from the application of that excessive temperature.

One of these conditions is the disproportion of the arc contact to the work area and the heat tempering influence which the latter exerts. Another, and that most important, is the fact that with the short arc the flow of metal between the electrode tip and the work is so rapid that it almost amounts to a continuous stream of sufficient density to establish a current bridge. In fact, the oscillograph has shown us that the current actually does short circuit the welder's arc an average of 25 times each second, and, while these shorts break the arc only momentarily, they afford sufficient relief to maintain an average temperature on the work which does not exceed safe metallurgic limits.

Following through the logic of this phenomenon it may be safely reasoned that with a current of low voltage, and low amperage also, there would not be sufficient energy to re-establish the arc after each of these short circuits unless the operator is content repeatedly to "commence again." The inevitable result of that method is uneven, porous welds, scaly surfaces and lack of fusion between weld and parent metal. A higher amperage, however, will tend to fuse off the elongated "necks" which form at the end of the electrode with each short circuit and insure a quick return of the arc.

Electrically Welded Seams for Plating

It is no longer necessary to hesitate about using electrically welded seams for plating because of any real lack of efficiency in that method. The brightest engineers of this generation are actively competing with each other in their efforts to gain first honors in welding research, and many problems of theory, which only yesterday were considered unsolvable by some, have now become the routine of every-day practice.

This may be accounted for in several ways, all of them, no doubt, contributing their share toward the more general success which has attended the extension of welding operations during 1920. Foremost in the list of causes may be found the growing spirit of "justice to all systems," which the welding engineer makes a first order of business the moment he begins an engagement. Trying to arc weld a gas job, and vice versa, simply because the "boss" happened to know more about one than the other, or because he had no equipment for doing it that way, has done much to prejudice owners and constructors against welding. Fortunately, the growth of the demand for welding has created a new and very useful official, the welding engineer, whose duties are to consider each undertaking on its own particular merits and to recommend how and by what method or system it shall be welded. For one job he may prescribe gas, for another thermit, and another arc or spot welding. He may, if he be a real engineer, turn down all of the autogenous methods and call in the riveters. There are many situations where the latter system is not only cheaper, but better.

Knowing what not to use is always an indication of real ability.

It is believed 1920 has witnessed the flood and we shall now have a decided ebb in the tide which has torn labor from its safe moorings on the question of service and that war-time demands will gradually give way to real effort to earn the pay envelope contents. The progress of welding has been noticeably impeded by the contention that however efficient a weld *might* be made, its real value lies in the

* Engineer welded ship construction; member, Society Naval Architects and Marine Engineers, American Welding Society.

quality of its workmanship, and welders, more than any other mechanics, have wholly failed to prove their loyalty by doing universally good work. Unfortunately, that contention is absolutely true, but, thanks to the perseverance of the devotees of this new art, a new spirit of interest beyond that of selfish monetary gain is being developed by the mechanics and we now find them constantly seeking advice as to how they may avoid the failures with which they have heretofore been charged.

Knowing how and the will to do it constitutes real team work, in the face of which failure is 99 percent eliminated.

Education of Welders

The very extended discussion which was given to Professor Chapman's paper on "University Education in Ship Construction" at the last annual meeting of the Society of Naval Architects plainly indicates a widespread interest in the betterment of the shipworker's mentality.

Nearly all large manufacturing concerns now provide for the education of their employees in such special lines as will enlarge their field of usefulness and the recognition which is being given to welding in this educational movement augurs well for its future establishment as a means of constructing ships.

Drexel Institute, in Philadelphia, may be cited as a good example of what can be accomplished in this line. They do not attack the problem from the trade school standpoint, but aim for the higher education of the welder by giving him the mathematics and the metallurgy of the art and so fit him to become a leader and a teacher. The practical part is treated by demonstration only; the actual experience must be obtained in the shipyard.

The American Welding Society

The importance of the welding art is reflected in no small measure by the activities of the American Welding Society, one of the newest but not the least vigorous of the American technical societies. Organized in 1919 as a logical outgrowth of the Emergency Fleet Welding Committee, a body of eminent engineers appointed to aid in winning the war, the society has grown until it now has upwards of 1,000 members with local sections in New York, Philadelphia, Pittsburgh, Cleveland, Chicago and other large centers.

Close affiliation is maintained by the society with the various Government bureaus, War and Navy Departments, National Research Council, Congressional and other libraries, chemical and metallurgical laboratories and other technical research organizations, to insure co-operation in any investigation undertaken by the society for the benefit of its members.

This is a society for promoting the science and art of welding and its accessory operations.

Attitude of the Classification Societies

While the classification societies have made no material change in their schedules of permissible welding, as, for instance, Lloyd's list of non-structural parts contained in the society's circular No. 1,328, approved by the committee October 6, 1919, greater latitude is continually being given to the local inspectors as to their interpretation of what shall and what shall not be welded in the construction of a ship. All such special rulings, however, have conformed to the general provision of Lloyd's circular No. 1,328, and the net effect has been to enlarge the volume of welding without encroaching upon the society's limitation of its use on non-structural parts.

Because of the builders' present state of unpreparedness, both as to equipment and personnel, this has not been considered a hardship. Our 1921 review will, no doubt, tell a different story, as the classification societies, both here and abroad, have all been keenly observing the progress of welding and will undoubtedly show their progressiveness by approving its use for strength members as soon as the builders are properly equipped for undertaking that form of construction.

In a leaflet recently issued by a prominent indexing firm, a list of permissible welding, which had been prepared from the paper on that subject published in Marine Engineering of April, 1920, was made to indicate that Lloyds might class all vessels whereon welding had been employed as "experimental" even though the amount of such welding might be very small.

Actually, there would be no such limitation to a vessel's classification, as above intimated, as where welding is confined to the circular No. 1,328 list of non-structural parts, the classification would remain 100 A-1 or 100 A-1, "awning" or "shelter deck with freeboard," without any notation in regard to the use of electric welding.

To put it still more clearly, in cases where it is proposed to adopt electric welding generally in the construction of vessels, Lloyd's Register requires the system of welding to be approved and the details of construction of the vessel and of the welds to be submitted for approval.

Provisional rules have been adopted by Lloyds as a tentative measure for the classification of vessels electrically welded, as provided in section 74 of Lloyd's rules for 1919-20, and the classification of such ships in the Register book bears the notation: "experimental" and "electrically welded."

The interest of the American Bureau of Shipping in the progress of welding is none the less keen and American Bureau of Shipping inspectors are everywhere on the alert to note its progress. Owing to the great similarity of rulings on that form of construction, i. e., as between the American Bureau and Lloyds, separate reference is hardly required, as any recital of the activities of one would be close akin to the other.

Welding Approved by Steamboat Inspection Service

It is not generally realized to what extent welding is approved by the board of supervising inspectors of the United States Steamboat Inspection Service, yet it is now a matter of current practice, under their direction, to weld cracks in front heads of main boilers, weld collars around fore and aft stays, weld all stays of furnaces and combustion chambers, reinforce all seams and rivet heads of furnaces and combustion chambers, weld tubes to flue sheet, weld all hard patches on all parts of boilers, weld cracks in shell of boiler, also furnace cracks, weld girth seams of boiler, build up boiler plates where pitted and corroded, build up worn and corroded tail shafts, repair hull plating rivet seams, fill out loose rivets, repair plate edge cracks, and many other repairs to boilers, fittings and the ship's structure, even where same may be subject to the Inspection Service regulations.

It should be borne in mind, however, that no welding operations may be undertaken under the auspices of the Steamboat Inspection Service until coupons showing the character of the work proposed shall have been made and tested, and the local inspectors are satisfied by personal investigation, whether the welding process can be safely used. Evidently the welding method is proving satisfactory in view of the many important repairs which are being constantly made on the pressure parts of the main boilers of numberless ships.

That being the case, why should the strength parts of a ship's hull be denied treatment by the welder's magic wand? Surely no greater risk to the ship's passengers would be invited by welding her frames than by repairing a 24-inch furnace crack in one of the main boilers.

Attitude of Shipbuilders Toward Welding

On the whole the attitude of shipbuilders generally may be said to be favorable. This view is a composite of the opinions of more than forty of our leading constructors, recently ob-

tained, and the fact that they actually are showing their faith in welding by investing heavily in equipment for its use proves conclusively that they recognize its value as a shipyard accessory.

North East Coast Yards

In the New England district there is perhaps less preparation for welding than in other sections of the United States, but this may be accounted for largely by the fact that the majority of the yards are devoted to the construction of wood or composite ships.

New York Bay or Metropolitan District

In what may be called the New York Bay or Metropolitan district the interest in welding is very keen. The constructors of that section appear to welcome opportunity for publicity in connection with their welding operations and announce their intention to extend its use as far as possible. Their reason for this is, no doubt, perfectly logical, inasmuch as the New York district yards are largely devoted to repair work for which arc and gas welding may be considered essentially a pre-requisite to success.

Delaware River District

The Delaware River district is now looked upon as the leading shipbuilding section of this country, the Delaware being called by many the Clyde of America. However true that appelation may be, it certainly is a great center for the welding industry, for in no other section have the constructors reported such relatively large numbers of machines and men. As other students may have learned, however, this is not the most fruitful of our country's districts in which to secure inside information concerning the shipbuilding industry, and much that might be told of the progress of welding in the Delaware river district must remain as a sealed book. Happily, there are exceptions to this, as in all cases.

Practically all of the modern methods are utilized, likewise some that are not so modern. One of the large Philadelphia yards, for instance, still adheres to the comparatively old carbon arc or graphite system of welding and appears to prefer it to all others. No doubt they have the good fortune also to retain some of the old-time operators who are peculiarly expert in manipulating the carbon electrode—men who have an inborn grip on the true metallurgy of their phase of the art just as the same firm still retains some of their old forge workers than whom no more expert wielders of the hammer and tongs exist today.

In other yards, both large and small, the gas and metallic arc methods may be found, sometimes one in the lead and sometimes the other, with no apparent reason why, unless it be the universal woman's reason, "because," or, what is equally convenient, "it just happens that way." Such reasons, however, are not likely to remain long unchallenged by those responsible for results. Anything obtainable was necessarily acceptable during the war period, but with the return of competition between shipbuilders it is altogether probable the fittest of the different systems will, in due course, appear as the sole survivor.

Middle Atlantic and Potomac River District

Some of our best shipyards are located in the Middle Atlantic section, and while all use welding to a greater or less extent, the number of men and machines employed differs greatly in the different yards. Some do not have any equipment whatever, but contract with outside parties to supply welding service as required. At Newport News a total of 156 gas and electric welders and chippers and 57 leaders, apprentices, chippers and helpers are employed in a single yard, and here it is that reports of progress are most gratifying. With them welding has become a fixed institution, and while the management do not feel prepared as yet to go on record relative to the further extension of welding, owing to its status as a comparatively new art, nevertheless "the street" is well satisfied the amount of welding now being regularly undertaken as a matter of routine at Newport News is proof positive that the above organization is not wholly engaged on corrective work.

The Navy Yard at Norfolk is generally regarded as the pacemaker in matters of research and development of welding for battleships and other governmental vessels. In carrying out this policy the different bureaus interested have supplied Norfolk with extensive equipment, they have organized training schools and they have expended large sums in demonstration work.

Gulf Coast Yards

Like shipbuilding generally, the progress of welding in the Gulf Coast yards is relatively uncertain. Many of the yards which sprang into existence during the war period have just as suddenly disappeared and the more permanent concerns are marking time until their future policy can be more definitely determined. Practically all of these yards have been using welding and will continue its use later, some, in fact, appearing to feel very favorable toward its further extension.

Great Lakes District

It may require the yards in the Great Lakes district some time to settle down from the excitement of their recent experiences in salt water shipbuilding. No more progressive constructors are to be found, however, and the response of the naval architect of one of the largest of the Great Lakes organizations may be considered indicative of the attitude of all when he states that up to the present time they have not made sufficient use of electric welders to develop any standard practice with respect to their use on certain parts of the ships, but they do expect in the future to extend their use of these appliances.

Pacific Coast Yards

The use of electric welding for ship repairs had some of its early beginnings on the Pacific Coast, but for new construction it was not generally adopted until recently. Now, as may be seen by reference to the Bethlehem Corporation's table, elsewhere referred to in this paper, the Union plants are making extended use of welding, and the same may be said of the yards in Seattle, Oakland, Long Beach, Los Angeles and other centers. At the Mare Island Navy Yard they are doing more welding than many of our Atlantic Coast yards; in fact, it is reported that the completion of an all-welded vessel to be used in connection with the salvage of airplanes only awaits the allowance of final appropriation.

Everywhere throughout the entire country there is a very general interest in the progress of welding, and one need not be unduly optimistic to believe the day is not far distant when that interest will have become an actuality—an every-day routine of ship construction.

Typical Examples of Welding

In order to add interest and value to our review of shipyard welding operations it is believed a few illustrations of typical jobs carried out at our American yards at different times will assist constructors to a better understanding of the value of welding.

Engineers have been able for a long time past to produce efficient welds, and while it is admitted the difficulties in the way of obtaining universally good jointures are serious principally on account of the personal equation, nevertheless very excellent examples of successful undertakings are continually being produced. A few of these may be mentioned.

Welding Crow's Nest

Electrically welding crow's nests to ships' masts is one of the very novel though useful applications of that method of

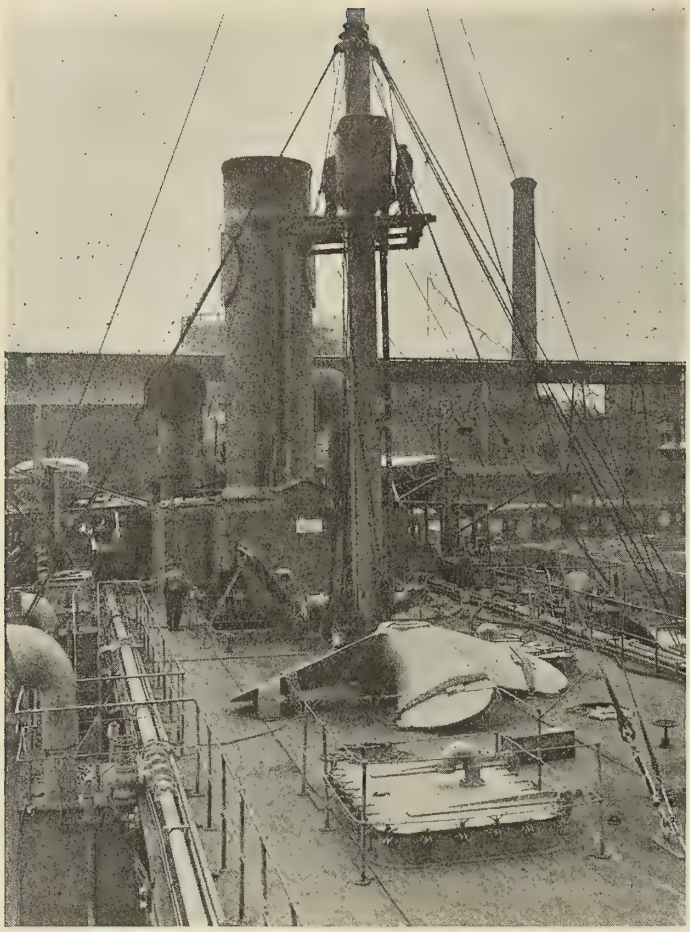


Fig. 1.—Crow's Nest of *Hisco* Welded to Mast by Electric Arc Process

construction. Fig. 1 shows a deck view of the steamship *Hisco* nearing completion at the Chester shipyard in 1917. The crow's nest structure required an unusual amount of "drawing up" to obtain a proper fit around the mast, but this was readily accomplished without providing a single assembly bolt and the weld was completed in much less time and at less cost than would have been required for former methods of making the connection.

Ventilator Pipe and Fittings

With properly regulated generators, light plate work such as engine room oil tanks, crank case drip pans, ventilator pipe, and fittings, similar to the group illustrated in Fig. 2, may be arc welded at much less expense for material and

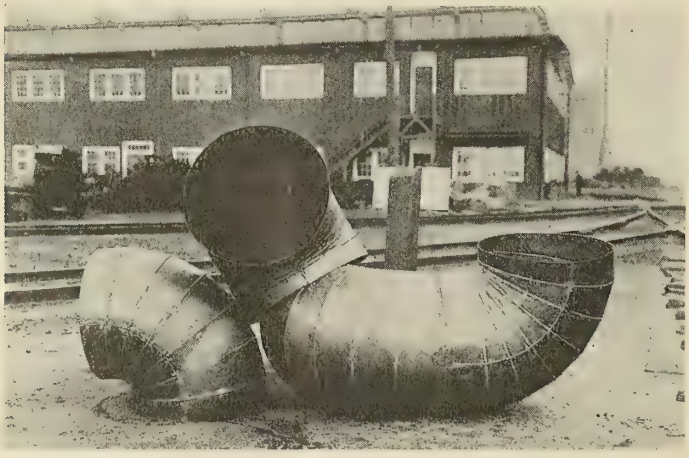


Fig. 2.—Arc Welded Ventilator Pipes

Fig. 3.—Sanitary Bulkhead Panel Spot Welded to Lugs Which Are Arc Welded to Frame

labor than is required for riveting, and when joints are rough ground their outward appearance is vastly improved.

Sanitary Bulkhead Panels

For comparison with the above, Fig. 3 illustrates a simple form of sanitary bulkhead panel. The panel plate is of No. 20 gage steel, spot welded to ⅛-inch lugs distributed along each edge and arc welded to the frame, as may be clearly seen in Fig. 3. The frame is made of standard steel pipe, arc welded at the four mitred corners.

The finished panel was tested by supporting the weight of seven men standing clear of the frame, their combined weight being entirely supported by the two ¼-inch spot welds which secured the panel plate to each of the eleven small lugs. The panel meantime was lying upside down in order to throw the greatest possible strain on the spot welds. The test did not develop the slightest indication of stress on any of the spots.

Engine Room Skylights

Photographs of an excellent example of engine room skylight construction (Figs. 4 and 5) have been contributed by Mr. E. H. Ewertz, general manager of the Bethlehem Ship-

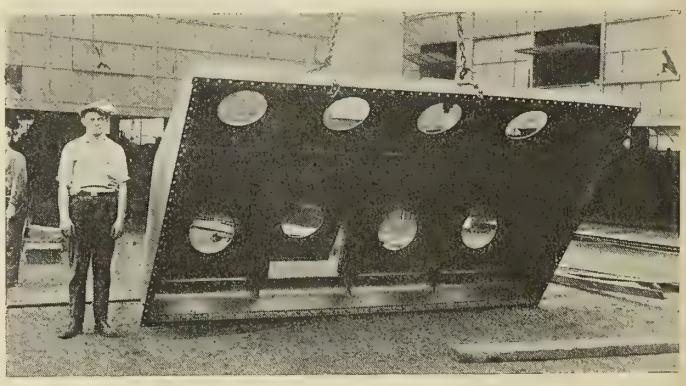


Fig. 4.—Interior of Engine Room Skylight

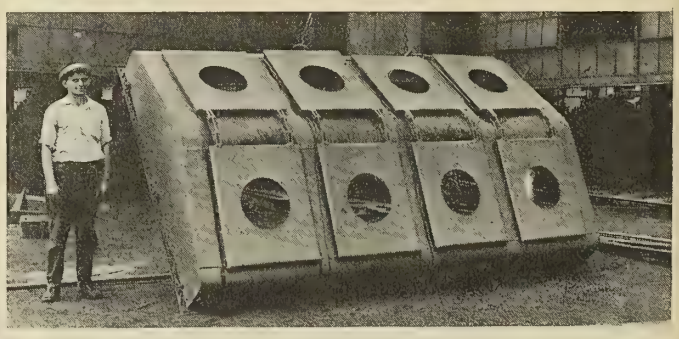


Fig. 5.—Exterior of Engine Room Skylight

RECORD OF WELDING WORK (ELECTRIC ARC)

BETHLEHEM SHIPBUILDING CORPORATION LTD.

PART OR ITEM WELDED	APPROVED BY CLASSIFICATION SOCIETY	FORE RIVER		SPARROWS PT.		HARLAN		MOORE		POTRERO / RISDON		ALAMEDA	
		OPERATION PERFORMED	REMARKS	OPERATION PERFORMED	REMARKS	OPERATION PERFORMED	REMARKS	OPERATION PERFORMED	REMARKS	OPERATION PERFORMED	REMARKS	OPERATION PERFORMED	REMARKS
Manhole Reinforcing and Protecting Angles	■	⊞		■	All	■		■		■		■	
Masts	□	⊞		⊞		⊞		⊞		⊞		⊞	
Mast Fittings	□	◧	Butts of Rings	◧	Butts of Rings	⊞		◧	Butts of Steps & Rings	◧	Small Pad Eyes welded to Decks Boom Seats to Deck	◧	BUTTS OF RINGS, SMALL PADS ETC WELDED TO MASTS AND DECKS
Attaching Flanges to Pipe	□	■		⊞		⊞		⊞		⊞		⊞	
Attaching Fittings to Pipe	□	■		⊞		⊞		⊞		⊞		⊞	
Conduit & Pipe Supports attached in Place	□	⊞		⊞		⊞		⊞		■		■	
Filter Boxes	□	⊞		⊞		⊞		◧	Corners welded	■		■	
Stanchion Collars attached to Stanchions (Hold)	□	⊞		⊞	H. Section used	◧	Butts of Collars	◧	Butts of Collars	◧		⊞	
Stanchions attached to Tan Top & Decks (Hold)	□	⊞		⊞		⊞		⊞		◧	Between Deck Stanchions welded to Deck	◧	Floor Stanchions under Engine Foundation
Boiler & Engine Foundations	□	◧	Top Foundation Platening Joints Destroyers	⊞		⊞		⊞		⊞		⊞	
Fresh Water Tanks	■	⊞		■		■		⊞	Intend to weld in Future	⊞		■	
Lubricating Oil Tanks	■	■		⊞		⊞		⊞		⊞		⊞	
Other Tanks	■	■	Oil Tanks	■		⊞		⊞		⊞		⊞	
Shaft Alley Escapes	■	■		⊞		⊞		⊞		⊞		◧	Pump Room Escape Trunks
Deck Houses	■	⊞		◧	Butts & Corners of Angle Framing	⊞		◧	Butts & Corners of Angle Framing	◧	Butts of Reaming Watertight Collars	◧	Companion Ways completely welded
Grab Rods on Exterior & Interior of Deck Houses	■	⊞		⊞		⊞		⊞		⊞		■	
Attaching Galley Fixtures to Casing	■	■	Destroyers	⊞	Bolted	⊞		⊞		⊞		■	
Attaching Bath & other Fixtures in Officers' Quarters	■	■	Destroyers	⊞		⊞		⊞		⊞		■	
Stacks & Uptakes	■	◧	Corners of Uptakes	⊞		⊞		⊞		◧	GALLERY STACK RINGS TO DECK & STACK SUPPORTS SHROUD PADS TO DECKS	⊞	
Smoke Stack Deck Collars & Angle Rings	■	■	Butts	■	Butts	■		■		■	Butts of Rings	■	Butts of Rings
Attaching Stack Deck Collars to Decks	□	⊞		⊞		⊞		⊞		⊞		⊞	
Smoke Stack Cape Rings	■	■	Butts	■	Butts	■		■		■	Butts of Rings	■	Butts of Rings
Attaching Cape Rings to Smoke Stacks	■	⊞		⊞		⊞		⊞		⊞		⊞	
Boiler Casings	□	■	Corners	⊞	Ends of Butt Straps of Scotch Boilers	⊞	Ends of Butt Straps of Scotch Boilers	⊞		⊞		⊞	
Coal Chutes	■	⊞		⊞		⊞		⊞		⊞		◧	Corners of Chutes
Cargo Batton Cleats in Place	■	⊞		⊞		⊞		⊞		■		■	
Attaching Deck Rail Stanchions to Platings	■	◧	Occasionally	■		⊞		⊞		■		■	
Attaching Deck Rail Stanchion Sockets to Platings	■	◧	Occasionally	■		⊞		⊞		■		■	
Awning Stanchion Clips or Brackets to Stanchions	■	◧	Occasionally	◧		⊞		⊞		■		■	
Joints of continuous Railing Rods	■	⊞		⊞	Pipe Joints made	⊞		■		■		■	
Bulwark Rail Tops	■	⊞		⊞		⊞		⊞		⊞		■	
Engine & Pump Foundation Pans	□	⊞		■	Plate Flanged & Corners welded	⊞		⊞		■		■	
Condensers	□	■	Butts of Frames Corners of Casings Aux. Con. Complete	⊞		◧	Corners of Casings & Butts of Framing	◧	Flanges & Fittings welded on Surface Cond.	◧	Rings only	◧	Rings only

Fig. 6

RECORD OF WELDING WORK

BETHLEHEM SHIPBUILDING CORPORATION LTD.

PART OR ITEM WELDED	APPROVED BY CLASSIFICATION SOCIETY	FORE RIVER		SPARROWS PT		HARLAN		MOORE		POTRERO		ALAMEDA	
		OPERATION PERFORMED	REMARKS	OPERATION PERFORMED	REMARKS	OPERATION PERFORMED	REMARKS	OPERATION PERFORMED	REMARKS	OPERATION PERFORMED	REMARKS	OPERATION PERFORMED	REMARKS
Hatch Coamings	☐	■		■	Corners	◪	Corners Occasionly	⊞		■		■	
Hatch Framing	☐	■		■	Butts	■	Butts	⊞		■		■	
Hatch Beading	■	■	Corners	⊞		◪	Corners	⊞		■	Corners	■	Corners
Hatch Covers	■	⊞		⊞		⊞		■	Flanged & Corners welded	◪	Corners only	◪	Fitting welded on
Oil Tight Hatch Covers	☐	◪	Butts of Bounding Ring	◪	Butts of Bounding Ring	◪	Butts of Bounding Ring	⊞		◪	Butts of Rings	◪	Butts of Rings
Pipe Tunnels	☐	⊞		⊞		⊞		⊞		⊞		⊞	
Shaft Tubes	☐	⊞		⊞		⊞		⊞		⊞		⊞	
Door Frames	■	■	Frames bent and welded at Butt	■	Frame bent and welded at Butt	■	Frames bent and welded at Butts	■	Angle Mitred and welded at Corners	■	Frames bent & Butts welded	■	Frames bent & Butts welded
Attaching Door Frames to Casing	■	⊞		⊞		⊞		⊞		⊞		⊞	
Doors Watertight	☐	⊞		⊞		⊞		⊞		⊞		⊞	
Doors Non-Watertight	☐	⊞		⊞	Pressed out of Solid Plate	⊞		⊞		⊞		⊞	
Attaching Hinges, Catches etc. to Doors	■	⊞		⊞	Riveted	⊞		⊞		◪		■	All
Galley Skylights	■	■	Work Started	■	All welded	■	Work Started	⊞		⊞		■	All Complete
Skylights over Accommodation Spaces	■	■	Work Started	■		⊞		⊞		⊞		■	All Complete
Engine Room Skylights	■	■		■	Stiffener Framing Riveted on	■	Work Started	⊞		⊞		■	All Complete
Engine & Boiler Room Gratings	■	■		⊞		■		■		⊞		⊞	
Attaching Framing & Supports for Grating	■	⊞		⊞		◪	Occasionally	⊞	Riveted	⊞		■	
Ladders & Stairs including Rail Attachments	■	⊞		■	Ladders only	■		■		⊞		■	
Screen End Bulkheads	■	⊞		⊞		⊞		◪	Butts of Bars only	⊞		⊞	
Bulkheads-Partition Bulkhead in Accommodation Spaces	■	⊞		⊞		⊞		⊞		◪	Bath Partition Bulkheads in Place	◪	Bath Partition Bulkhead welded in Place
Bulkhead Bounding Bars, Butts & Corners welded in Place, O.T. & W.T.	■	⊞		■	Welded in Place after Riveting	◪	Occasionally	⊞		⊞		⊞	
Bounding Bars, Butts & Corners of Floors, O.T. & W.T.	■	⊞		■	Welded after Riveting	⊞		⊞		⊞		■	In Place
Plate & Angle Staples	■	■		■		■		■		■		■	
Angle Corners	■	■		■		■		■		■		■	
Angle Collars, Watertight	■	■		■		■		■		■		■	
Ventilator Vent Pipes	■	⊞		◪		■		⊞		⊞		■	
Ventilator Coamings	■	⊞		◪		■		◪	Butts welded	⊞		■	
Ventilator Cowls	■	⊞		◪		■		◪	Handles welded on	⊞		◪	
Ventilator Angle Rings	■	■		■	Welded at Butt	■	Welded at Butt	■	Welded at Butts	■	Butts	■	Butts
Attaching Ventilator Angle Rings to Deck	☐	⊞		⊞		⊞		⊞		⊞		■	
Attaching Cowl Supporting Rings to Ventilators	■	⊞		⊞		⊞		⊞		⊞		■	
Manholes, Oiltight and Watertight	■	■	Butts of Rings	⊞		■	Butts of Rings	⊞		■	Butts of Rings	■	Butts of Rings
Manholes, Non-Watertight	■	⊞		⊞		⊞		⊞		⊞		⊞	

Fig. 7

RECORD OF WELDING WORK
BETHLEHEM SHIPBUILDING CORPORATION LTD.

PART OR ITEM WELDED	APPROVED BY CLASSIFICATION SOCIETY	FORE RIVER		SPARROWS PT.		HARLAN		MOORE		POTRERO		ALAMEDA	
		OPERATION PERFORMED	REMARKS	OPERATION PERFORMED	REMARKS	OPERATION PERFORMED	REMARKS	OPERATION PERFORMED	REMARKS	OPERATION PERFORMED	REMARKS	OPERATION PERFORMED	REMARKS
Tack Welding of Floors, Frames etc. for Bull Riveting		⊞		⊞		■		⊞		■		⊞	
Attaching Feed Water Heaters to Foundations	■	■		⊞		⊞		⊞		■		⊞	
Foundations (other than Boiler and Engine)	□	⊞		⊞		⊞		⊞		■		■	AFTER WINCH FOUND DYNAMO FOUNDATION WELDED COMPLETE & TO DECK OR FLAT
Valve Guard (Tankers)	■	⊞		⊞		⊞		⊞		■		■	All Completely Welded and to Place
Garbage Chutes	□	⊞		⊞		⊞		⊞		⊞		■	Completely Welded & Welded to Place
Platform Hangers to Bulkheads in Engine and Boiler Rooms	■	⊞		⊞		⊞		⊞		⊞		■	Welded in Place
Boom Seatings or Supports	□	⊞		⊞		⊞		⊞		⊞		■	Welded to Deck
Deck Pipe Stands (Tankers)	□	⊞		⊞		⊞		⊞		■		■	Completely Welded and to Deck
Tank Stands	■	⊞		⊞		⊞		⊞		■		■	Welded to Decks or Flats
Sockets for Boat Davits	□	⊞		⊞		⊞		⊞		■		■	Welded to Deck
Watertight Collars on Longitudinals	■	⊞		⊞		⊞		⊞		■		■	Welded in Place All
Supporting Bars for Pump Room Platforms	■	⊞		⊞		⊞		⊞		⊞		■	Completely Welded in Place
T-Bars on Decks for Cadet Rooms Partitions	■	⊞		⊞		⊞		⊞		⊞		■	Welded in Place to Deck
Running Light Shields	□	⊞		⊞		⊞		⊞		■	Welded to Bridge	⊞	

Fig. 8

building Company's plant at Elizabeth, N. J. In the construction of these skylights, Mr. Ewertz states that no anglesmith or blacksmith work or riveting of any kind was used. As the photographs plainly show, a great deal of material originally used in skylight construction has been eliminated, and yet there is every evidence of strength and rigidity in the construction.

Towing Target for the United States Navy

A large part of the welding done for purely demonstration purposes is of little value to shipbuilding interests. This is noticeably true of the much exploited towing target which was constructed at great expense by one of our Navy Yards, and which had its first sea trials about a year ago. As a demonstration of methods of assembly, welding procedure and process welding, it would have been valuable to constructors obliged to consider costs only as showing them what should not be done. The welded portions might, with equally efficient results, have been fastened together by bolts, as the plating was used merely to form a container for the heavy buoyancy timbers and to furnish a much-needed trimming keel. No reference to watertightness appeared in the specification.

Scheduling Welding Operations

Like the Wagnerian theme, which that composer threaded through all of his operas, Lloyd's list appears as the foundation of welding operations in practically all of our American yards, and it is only through local conditions, or interpretation by specializing engineers, that modifications appear.

One excellent example of this local interpretation is shown in accompanying reproduction of Record of Welding Work carried out at the different yards operated by the Bethlehem Shipbuilding Corporation (see Figs. 6, 7 and 8). This is a most convenient method of setting up an otherwise awkward list of details, for it shows at a glance not only what is being welded or not welded at the different yards, but the extent also to which each item is fabricated by that process.

Miscellaneous Suggestions for Welding

The sketches for various ship fittings and fixtures which may be advantageously welded, as shown in Figs. 9-16, will suggest to the constructor many ways in which he may reduce

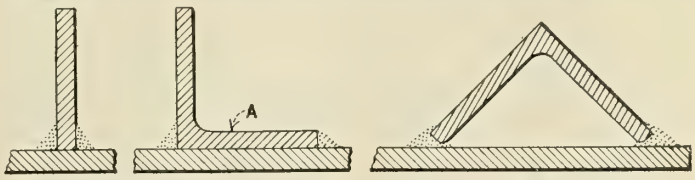


Fig. 9 Fig. 10 Fig. 11

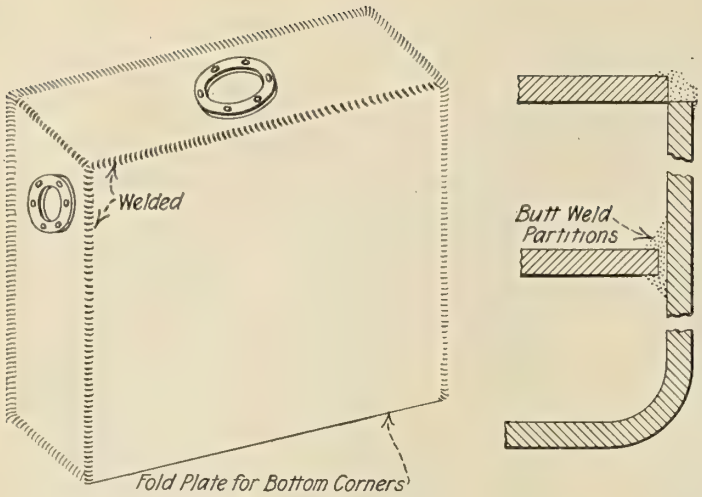
If large single plates are used in the fabrication of deck houses, bulkheads or other structures, the unsupported areas may be stiffened by bar or angle ribs as above.

his weights and costs. Many of these fittings and fixtures are regularly produced by different yards as a part of their standard construction and those in actual use have proven entirely satisfactory.

Plant Maintenance

Fig. 17 illustrates an electrically welded break in the side frames of one of the 35-ton yard locomotives operated by the New York Shipbuilding Corporation in its Camden plant. Similar repairs were made in another locomotive of the same type.

These repairs were made some time ago, and while the engines have since been engaged in heavy work day and night,



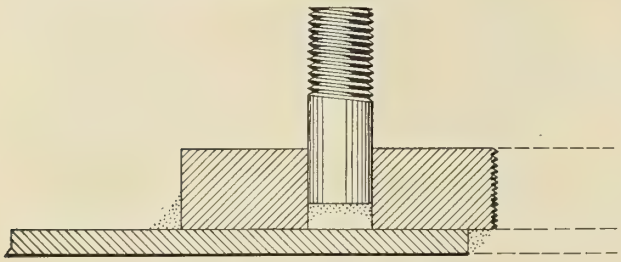
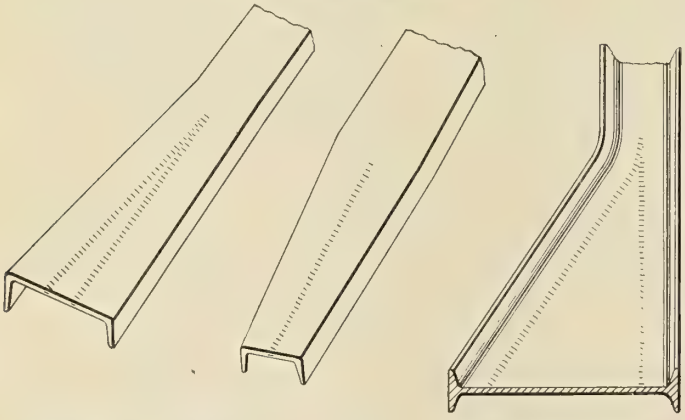


Fig. 12.—Fresh Water Tanks



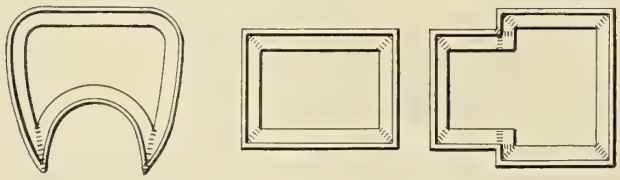


Fig. 13.—Angle Smith Work

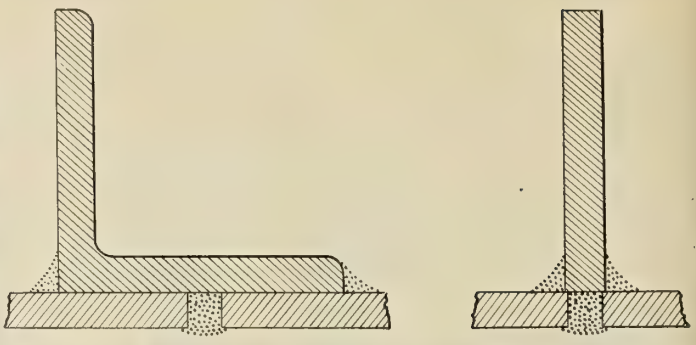


Fig. 14.—If Skylight Casing is Made in Sections, the Plate Edges May Be Butt Welded with Inside Angles Utilized as Backing Straps as Shown Above

Fig. 15.—For End Seams or Other Jointures Occurring Between Landings, the Plate Edges May Be Butt Welded or Butt Strap Welded as Shown Above

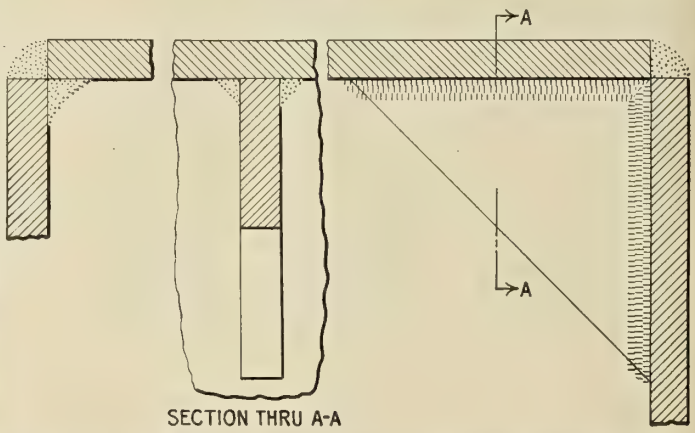


Fig. 16.—For Skylight Casing Corners it is Recommended That All Angles Be Omitted and Plates Joined as Above. Where Additional Bracing is Required, Small Gusset Plates May Be Inserted at Intervals of 12 Inches or More, and Fillet Welded on Each Side

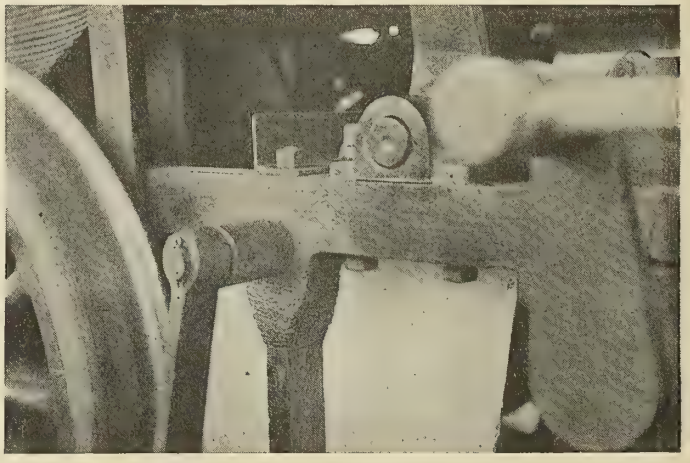


Fig. 17.—Welded Break in Locomotive Side Frame

the welds are holding perfectly sound, notwithstanding they are constantly subjected to severe shocks incident to passing over rough crossings, and, what is even more trying, the strains due to sudden setting of the brakes (note position of brake levers).

Both of above jobs are excellent examples of the great value of electric welding as an adjunct of plant maintenance. With no other expense than that for the labor of chamfering the

edges of cracks for fusing in the new metal, both welds were quickly made and the engines restored to service. By any other method of repair they would have been out of commission many times the number of hours required for welding and the cost would have been very great.

The Selection of Welding Equipment

It is interesting to note the great diversity of plans followed by different shipyards for the supply of their welding current. Thus far many of them appear to have chosen their equipment rather for emergency requirements than for efficient, economical production service. Some have shown very plainly their acceptance of the idea that electric welding is merely a corrective art and, therefore, requires only such equipment as may be carted about the yard to plug up mispunched holes, fill up cavities in castings and the like. Others, fortunately for their own best interests, appreciate welding as a constructive art and their equipment plainly shows their confidence that it will justify the same careful selection of machines and the same substantial installation as that provided for other equipment of established lines.

A good illustration of the latter is shown in Fig. 18, which shows one corner of the welding shop established by the New York Shipbuilding Corporation for their North Yard. Each of the welding sets included in the photograph is a 175-ampere unit of the most modern and efficient type obtainable. They are designed for low speed service and have an easy overload capacity for operating at 250 or 300 amperes for extended periods, and are therefore capable of caring for any type of welds, whether heavy or light.

In order to meet the demands of shipyard service, the selection of welding equipment presents many problems unheard of in other lines of manufacture. It is not possible to make any installation for field service permanent because of the constantly changing condition of the work on the ways. To meet this condition, some yards select portable machines mounted on trucks, but these have not been found satisfactory, as yard transportation is very different from shop transportation and small-wheeled trucks are of little use.

The portable sub-station has proven about as convenient as any other method, as it meets every condition of semi-permanence and provides storage for such tools and supplies as are immediately required in every-day service. One of these portable stations has been adopted by the Sun Shipbuilding Company at their Chester, Pa., yard. This car has been in service upwards of three years and has proven not only efficient for the purpose for which it was built, but also as an example of welded construction subject to severe test. The car was built entirely of steel, electrically welded throughout.

The Progressiveness of Welding

Any suggestion that the more or less generous use of welding by our ship constructors can be taken as an indication of their progressiveness would no doubt be resented by many; nevertheless the implication is pretty generally true.

We regard with awe the remarkable record of the Hog Island yard and the terrific pace maintained by its managers in their efforts to supply Pershing with his bridge of ships. Complaint has been made that the Hog Island venture cost "a mint of money." What if it did? It was well worth the price to learn what brains and enterprise can accomplish, and Hog Island *did things*. In thirty-eight short months they converted a scrubby swamp into a 50-way shipyard, built and delivered 115 completed ships, which, within that same period, have carried considerably more than 3,000,000 tons of cargo to every corner of the globe.

The same critics also object to the Hog Island ships as poorly designed, expensive to operate and maintain, and unseaworthy. It may be so, nevertheless they already have a steaming record of over 3,100,000 ship miles. They have not

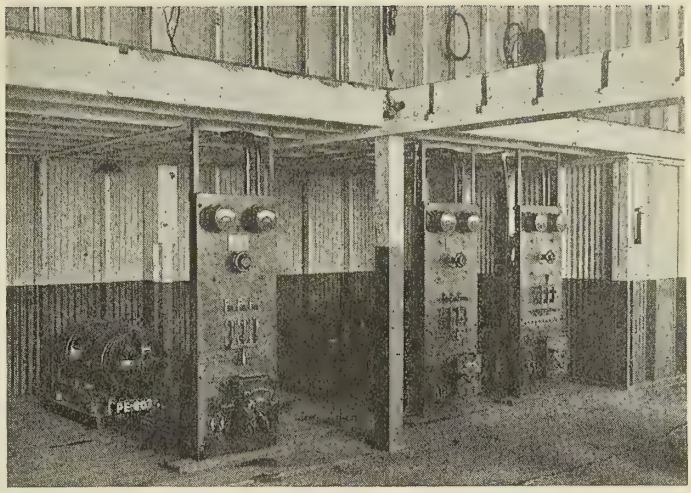


Fig. 18.—Corner of Welding Shop, New York Shipbuilding Corporation

only kept afloat, but hold enviable records for seaworthiness, and the number of "lame ducks" they have rescued on their voyages.

In this connection it is interesting to note that the Hog Island management strongly advocate the use of welding. In fact, they have used it very freely in all of their construction, yet we hear no reports that their welds have failed.

Many instances of the progressiveness of our shipbuilders have been recorded wherein a disposition to accept welding as a constructive measure of undoubted reliability has won glory and profit to them and aided in victory for our Army and Navy. As usual, however, there have been those who see only the seamy side, and, without lifting a hand to assist in eliminating the difficulties, which we know do stand in the way of universal success in the use of welding, they refuse either to try it or speak a friendly word in its favor.

When the shipbuilders learn to accord to welding the confidence as well as the dignity and class which it deserves, and labor also realizes that therein lies hope for a happy solution of their problem of the pay envelope, we shall begin to enjoy the fruits of our contest for its recognition as a productive and a constructive art.

It is all right to use welding for corrective work, as far as it need be so used, but, with apologies to our President, let us hold our men to the same strict accountability for avoiding the necessity of corrections as they were admonished to use prior to the introduction of that handy method, electric welding.

Electric Drive in the Navy.—The electrical operation of the Navy's six new line battle criusers, now building under the 1916 naval programme, will represent, according to Rear Admiral R. S. Griffin, Chief of the Bureau of Engineering, "The greatest horsepower per shaft that has ever been projected in any marine installation irrespective of the type of motive power." Speaking of these war vessels, and of the six new battleships, also part of the programme, and emphasizing what this means in making the United States pre-eminent among all nations in marine engineering, Admiral Griffin says:

"In the case of battleships Nos. 49 to 54, the installations represent an increase to 60,000 horsepower, that is double the most powerful electric drive installations previously designed, and in the battle cruisers 180,000 horsepower is to be carried by four electrically-driven shafts.

"This," he continued, "is by far the greatest horsepower per shaft, so far as this bureau is aware, that has been projected in any marine installation irrespective of the type of motive power."

Marine Terminals and Port Facilities

BY FLOYD T. SMITH*

A look ahead into the coming year shows many huge port developments contemplated. The Atlantic, Gulf and Pacific coasts are dotted with many cities which have planned improvements. Our larger and much improved merchant marine makes necessary terminals of the latest design or improvements in existing structures that will give a quicker turn around of ships and provide better facilities for both export and import trade.

FACILITIES which the port requires should include good harbors, deep channels, wide piers, warehouses and pier sheds of improved construction to accommodate the shipping which comes to it, but one of the most important of all necessary facilities is the loading and unloading methods and mechanical equipment that permits quick dispatch. Other necessary services which the port should provide are dry docks, repair plants and coal and oil bunkering facilities.

The port grows in direct proportion to the shipping drawn to it. A big asset to any seaport is the ample terminal capacity in which the latest mechanical equipment has been installed and which will compensate for the difference in cost of operation in this port and elsewhere. The chambers of commerce and boards of trade have proven to be public spirited and have shown with results that followed that the many cities were anxious for trade and in a position to take care of it. Naturally the proximity to the ocean is of vital importance, but equally true is it that the terminal facilities of a port somewhat removed from the ocean may be such that a ship could be loaded and unloaded in such time as more than compensated for the extra time required for the same ship to run over the longer distance.

Ports are necessary outlets and inlets for commodities of all kinds. It is a big advantage in regular liners and tramps tying up directly to broad, deep water piers and wharves where they may be loaded and unloaded without resorting to the slow and expensive process of lightering the cargo.

Need of Port Development

Any city desiring to become recognized as a factor in handling water-borne commerce should give careful consideration to the need of port developments, as plainly outlined by the Montreal Harbor Commission:

"The ports that are doing the biggest business, and doing it most efficiently, are the ports that have kept their facilities ahead of actual requirements.

"The ports that have remained stationary or lost in prestige have been those which neglected to provide facilities before business was forced to seek elsewhere the same facilities provided by rival terminals. Business follows the facilities.

"Unity of authority, concentration of business, depth of water areas and facilities for despatch of business are the prominent characteristics of successful port administration.

"The necessity of providing large and convenient storage areas where cargo may be collected and cared for.

"The lowest cost of handling cargo from the hold of the ship to consignee, and vice versa, was found to be in a port where one authority controlled the entire operation, and where transit sheds were three to five stories high.

"Great port developments have invariably been followed by increase of trade and population."

Congestion, delay and excess cost at a port terminal are shown in the profitableness and eventually in the growth of the foreign trade which passes through it. The cost of moving goods by railway or ship amounts only to a fraction of the cost of handling them through the terminal. It is not possible that further great economies can be effected in either rail or water transportation, but it may be possible to reduce terminal costs greatly through the use of more modern equipment and the co-ordination of facilities to eliminate unnecessary handling or movement of goods within the port.

The Traffic Problem

The most vital problem of practically all port terminals is essentially a traffic one. It is either the provision of cargo for ships which otherwise would have to leave in ballast or the securing of markets capable of absorbing the product brought by ships which otherwise would have to go empty. Operating ships in ballast means an operating loss, and ports which cannot assure vessels of cargo both ways are badly handicapped in building up their overseas shipping services.

There are many examples of serious difficulties in this respect among American ports. For instance, the physical volume of imports of material for manufacture, which enter through Boston for use in New England, normally greatly exceeds the volume of export which New England can furnish. To attract shipping lines, therefore, Boston's problem is to secure bulk freight for export from regions outside of New England. At Galveston, cotton exports tremendously overbalance the volume of imports and the same situation may be said to exist in other southern ports. Most American ports have been developed as the terminals of a very few principal railways. Competition among the various ports and the railways which serve them has occasioned many rate wars and disputes. The outcome as regards north Atlantic ports has been the establishment of differential rates on export traffic which favor Baltimore and Philadelphia, as against New York and Boston, a handicap which has seriously hampered Boston's efforts to secure bulk cargo, such as grain, with which to balance her imports. New Orleans, likewise, has secured a preferential rate, approximately that between eastern ports and Chicago and the central part of the country.

There has been considerable agitation as to the advisability of making huge appropriations, and much thought has been given as to whether or not the vast sums expended for important port facilities could be considered a paying investment. Without doubt the results obtained at the huge terminals constructed and in part put into operation during the war period have demonstrated and conclusively proven what modern equipment could accomplish. The terminals so equipped were the army supply bases at Boston, Brooklyn, Newark and Norfolk.

Huge Sums to Be Expended by Ports

The total amount to be invested by ports themselves or by private interests will in many harbors greatly exceed pre-war figures. New York City, one of the great war ports, even now at the expenditure of tens of millions of dollars has no adequate permanent docks for proper handling of cargo ships and great quantities of cargo, excepting, of course, the Brooklyn Army Base and Bush Terminal. Boston, Philadelphia and Baltimore greatly benefited by great expenditures during the war. Philadelphia with her municipal piers has gained the reputation of being well equipped. New Orleans was the only gulf port in which extensive port improvements were

* Power and Mining Department, General Electric Company, Schenectady, N. Y. Member, Terminal Engineering Society; associate member, American Institute of Electrical Engineers.

Fig. 1.—A Ship from the Orient with a Two-Million-Dollar Cargo, Bush Terminal

made. Mobile and Galveston are so favorably situated that a great deal may be expected of them in the future as world shipping ports. The Pacific Coast of the United States is one of the few sections of the world provided by nature with commodious harbors. Puget Sound on the north is a great inland sea with about 1,500 miles of coast line. No dredging is required for ship channels, and this is an asset of prime importance. San Francisco Bay is a harbor second only to Puget Sound. Seattle ranks first in the commerce of the Pacific Coast ports, first in the huge port terminals, just completed, and first in material handling equipment. Our several Great Lake port terminals are world renowned as examples of ports with efficient mechanical apparatus for bulk cargo handling.

It has been said that New York handles material in a similar manner to that used a century ago. This is true, but the plans that have been made for intended improvements very clearly show that the thought uppermost today is that the old equipment must go or be improved and that new must be built. Just as New York has been the most backward of ports in making the most needed improvements, so now it would appear it is the most forward in the large future developments contemplated. At least three huge terminals in New York Harbor will be built. They will be located at Staten Island, Weehauken and Greenville.

$25,000,000 Terminal on Staten Island

The Staten Island development has been started. There will be fourteen great modern ocean piers which are now in the course of construction at an estimated cost of twenty-five million dollars. This sum is provided by a serial issue of bonds. So great has been the demand for adequate port facilities that every one has been leased advantageously, in advance, for a period of thirty years. These fourteen piers will take care of a great deal of the transatlantic traffic, which, at the present time, is unable to find adequate accommodation.

For the vast bulk of freight destined for distribution to points south of the Hudson, and westwardly through the range of states bordering the Great Lakes and for freight originating in these sections for trans-shipment abroad, these movements will in the future be handled very largely on the New Jersey side of the harbor. This would indicate a very favorable location for the terminal on Staten Island.

Unfortunately, one of the most striking features of the layout of the Staten Island piers is their extreme narrowness compared with modern piers in other ports. All of the Staten Island piers except two are about 125 feet wide. In the opinion of many port engineers this may prove to be a very serious error, which later results will verify. Another feature is the failure of most of the piers to take advantage of the opportunity afforded by the proximity of the Baltimore & Ohio Railroad tracks in their rear to make direct rail connection between them and this important trunk line railroad. When we consider that perhaps 75 percent of the import freight arriving in New York Harbor is destined for transfer into the interior of the country by rail, and that an equal proportion of the export freight arrives by rail, this lack of pier tracks would indicate a vital point overlooked. Some of the piers will be provided with cranes for cargo loading and unloading and for monorails, hoists and other equipment inside the pier sheds. On the other piers not so equipped the wise pier operator who has learned many a practical lesson in these days of increased cost and decreased efficiency will no doubt provide, wherever possible, modern freight handling equipment.

Equipment of Cunard Piers

The Cunard Steamship Company has acquired 3,600 feet of shore frontage at Weehauken, N. J., on the North River opposite New York on which it is proposed to erect eight steel concrete double decked piers 1,000 feet by 158 feet wide. There is to be a five-story reinforced concrete warehouse, a feature of which will be enormous operatorless elevators, capable of carrying a number of loaded trailers. Speed in vessel loading and unloading is paramount and mechanical handling is the secret of efficiency.

Fig. 2.—Piers A and B, Smith Cove Terminals, Seattle, the Two Largest Piers in the United States. Pier B, in

The purchase of cargo handling equipment will embrace the most modern appliances for the economical and expeditious handling of cargo. Tractor and trailer service will be used extensively. Cranes for the extensive cargo operations will be installed in large numbers and the entire layout will doubtless represent the latest creations in terminal development. By the building of this modern freight terminal the Cunard Line's vessels will avoid the congestion in the port of New York and will connect direct with the principal railroads. The expense and delays due to the present long lighterage hauls will thus be dispensed with.

Maine Projects

Portland, Me., the "Sunrise Port" and the most eastern of our large terminals, is also planning development. In order that the harbor facilities at this port might be made available for the other rail lines entering there, as well as the Grand Trunk, plans are now under way for the erection of a concrete and steel state pier and permission to extend the harbor lines 500 feet at the site of the proposed state pier and the Grand Trunk piers has been granted by the War Department to the city of Portland. The several steamship lines that have not heretofore utilized the port have investigated the proposed facilities and have signified their desire to make use of the same when available.

Baltimore's Port Developments

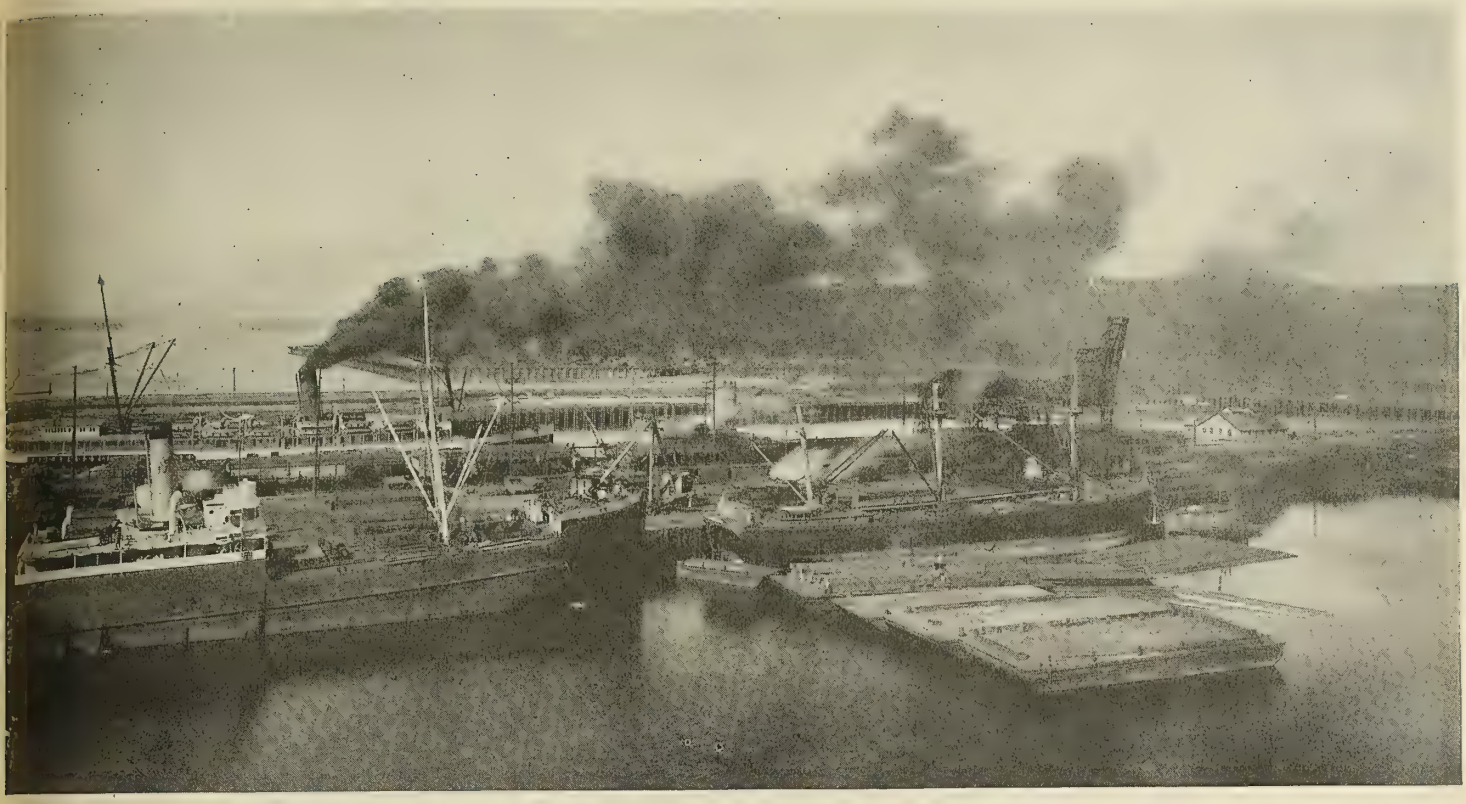
Baltimore's natural facilities include a large land locked harbor, dredged to 35 feet. Baltimore is the most western of the eastern ports, the most northern of the southern ports and the most southern of the northern ports. It is only a question of time until this port's facilities will be unable to handle the volume of traffic concentrated there or accommodate the vessels seeking berth space. The apprehension among steamship operators is that if the foreign trade of the United States should in the near future expand considerably, which may safely be assumed as inevitable, and if Baltimore should participate in this expansion to any great extent, which she will, the shortage of wharfage would be acute and would warrant the expenditure involved by them in leasing such facilities.

Within the past few years the city of Baltimore has expended about three million dollars for deepening the channels in the harbor and over nine million dollars for public wharves, docks and marginal streets. In addition to this, the Maryland Legislature has this year passed an act empowering the city of Baltimore to borrow fifty-two and one-half million dollars to be applied to the construction of wharves, docks, piers, warehouses and other waterfront development. The first instalment of ten million dollars of the fifty-two and one-half million dollars loan has been ratified by the people of Baltimore and within a very short time the first of this huge development programme will be started.

Southern Ports

The city of Norfolk has taken over, under contract with the War Department, a portion of the army supply base and is operating pier No. 2. In the harbor, the city of Portsmouth is proposing to spend $3,500,000 in the construction of municipal docks, piers and warehouses. The plans include provisions for two piers, two warehouses and the building of railway connections so as to facilitate shipments from the public docks at Pinner's Point. The proposed piers will each be 1,200 feet in length and the warehouses four stories in height with an enormous ground space.

Although the port of Philadelphia may be said to be well equipped, still to take care of future import and export trade the port plans an enormous development estimated at many millions of dollars for piers and dock construction, the programme including cranes, hoisting and conveying and other necessary machinery. Immediate construction estimated at $11,000,000 is to include new piers, each 1,200 feet long by 300 feet wide, with machinery installation. Other work will include the construction of similar structure at the Moyamensing pier group.



the Immediate Background, Has Since Been Completed and Passenger Sheds Built Close to the Street Side

Pacific Coast Developments

On the Pacific Coast the increase in the population of coast cities, the near future influence of the Panama Canal, the many absolutely necessary new routes of trade to the Orient, together with the surety of more manufacturing being carried on in the future of the coast, all demand the location of a real terminal in San Francisco Bay. With this in mind, plans for a multiple story ocean and rail warehouse terminal in San Francisco have been approved by the Board of State Harbor Commissioners.

The improvements will cost approximately $2,300,000. The creation of an industrial property and the erection of a six-story warehouse will take care of the seasonal as well as transient cargoes on the north side of the channel at China Basin. Belt railroad tracks on the wharf and behind the warehouse will be constructed and such other tracks as may be necessary adequately to serve the property. Improvements on the south side of the channel will provide a berth 830 feet in length.

The plans adopted combine a railroad and ship terminal, to be used as either. The terminal will include concrete warehouses and facilities for light manufacturing, a freight storage yard, transfer platforms, switching and team tracks, driveways and freight sheds. It will be used as a place for the accumulation of freight, to minimize idle time of ships and cars.

With facilities offered for the rapid handling of freight, it is the purpose of the plan that a ship can be unloaded as rapidly as stevedores with the aid of modern machinery can perform, and then warped into another berth, loaded and sent to sea. It is also the purpose of the plan to unload freight cars and subject them to as little delay as possible. The development will include harbor works, warehouse and factory development, worked out in an ideal way, which will require many years for production in its entirety, but the plan, however, is arranged so that a beginning may be made along the waterfront immediately and so that each unit will operate independently of the others, and that it may be increased gradually upon exact lines in the future by adding units toward the completion of the whole.

Seattle the Best Equipped Port

Seattle, the metropolis of the Pacific northwest, and now the best equipped port, has practically completed its ocean terminal. Noteworthy during the year was the completion of the work on piers A and B, Smith Cove terminal, and the public terminal system now claims the two largest cargo piers in the world. Pier A, distinctly a freight terminal, has the most complete mechanical appliances of any single dock on the coast. Pier B is the largest commercial pier in the world, being 2,543 feet long and 365 feet wide, with a berthing space for eleven ocean-going ships. With the idea of service in mind, the piers are equipped with mechanical devices with a range of capacity for the handling of a small case of salmon weighing 70 pounds to a locomotive weighing 100 tons.

The great gain of directly operating these publicly owned terminals as a business concern lies in the fact that the terminals are open to all commerce. A ship can sail into the harbor of Seattle from any place in the world, can secure a berth at one of these publicly operated docks without any cost whatsoever for berthing. When one compares this situation with conditions in other ports where steamship lines are paying many thousands of dollars each year for narrow and inefficient terminals, one can readily appreciate the significance of a port with such facilities.

The port of Astoria, located on a peninsula between Youngs Bay and Columbia River, is well situated for extensive ocean commerce. Here during the past year another modern terminal has been constructed and put in operation. The total berthing space of the two piers will be 11,700 linear feet. These piers are served by the Spokane, Portland and Seattle Railroad with a direct connection to the interior by a water level grade. This terminal has the proud distinction of being well equipped with material handling devices and the design and construction permit the ready operation of all in connection with the railroads for quick loading

Fig. 3.—The National Terminal at Boston, Mass.

and unloading. Award has been made for still further construction to consist of pier No. 3 and a freight shed, which shows the foresighted planning of the port of Astoria commission.

The first unit of development for the port of Tacoma will comprise dredging and filling and the construction of an open storage pier for the handling of lumber and miscellaneous open storage cargoes, a transit shed for the handling of ocean-going ships and cargoes, and railway and railroad connections. The open storage pier constructed under the first unit of development will have a length of 800 feet and a width of 166 feet, with a further extension amounting to a total width of 266 feet and a length of 1,200 feet. This pier will be equipped with hammerhead cranes for the quick handling of lumber from barges to storage and from storage to ship's tackle. The transit shed on pier No. 2 will be 1,000 feet in length by 180 feet wide, with an open wharf 35 feet in width on the slip side, containing two railroad tracks. The outside of the shed will be equipped with semi-portal gantry cranes for handling cargo to and from ships and the interior of the shed will be provided with monorail hoists for the distribution of cargo inside the shed.

Expenditures at New Orleans

The Louisiana Legislature has recently passed a bill authorizing the Board of Commissioners of the port of New Orleans to issue $6,500,000 more in bonds for the improvement of the port. Most of this amount will be provided to increase the number of wharves on the river front, as wharfage now is so scarce that from three to fifteen vessels are tied up in the stream at all times awaiting the opportunity and space to unload and load cargoes. It is also planned to start work on the first unit of the development near the Catalina Island steamship terminal.

On the Great Lakes

Plans have been approved for a water and rail terminal for Milwaukee. From the present breakwater six piers will be built, each 700 feet long and 300 feet wide. The docks will be of cement and equipped with the most modern machinery for handling freight. Double railroad tracks will be laid along the sides. Back of them will be four warehouses. Cranes will lift freight from the vessels. The docks north of the harbor entrance will be used principally for package freight bound to and from Milwaukee. The filled in land at the west end of the docks will be occupied by warehouses and railroad tracks.

Improvements for Handling Bulk Freight

This outline has been descriptive of terminals and piers for the handling of so-called package freight, but something should be said of the contemplated improvements for the handling of bulk material. Such a layout is naturally of entirely different type. In the terminals briefly described all of the commodity passes in or out of the ship's hatch by slings and crane or by an unloader, and the unloading and loading operation is far from being as continuous in performance as that used in the handling of bulk material. The so-called L.C.L. freight of less than car load lots or types of package freight must necessarily be carefully stowed in loading, requiring time and money. Similarly, in unloading, the commodity is loaded onto a car or onto some type of apparatus for movement to temporary or permanent storage in warehouse or pier shed.

For bulk or free flowing freight the material in loading is run or conveyed into the ship in practically a continuous stream and later mechanically trimmed. Immense mechanical coal and ore unloaders make a ship's stay in port a short one. Such loading and unloading terminals for bulk freight are generally the outlets of railroads and the locations have naturally been on the Atlantic coast or the Great Lakes. Two large railroads are now planning, on the Atlantic coast, new bulk material handling terminals of this kind.

Fig. 4.—Hulett Ore Unloaders at the Ohio and Western Pennsylvania Dock Company, Cleveland, O.

The harbor facilities of the Lehigh Valley Railroad plans the construction of a new rail and deep water terminal in the Greenville section of Jersey City and on New York Harbor. The plans provide for three of the largest piers in the world. When completed, the piers will provide dock space six miles long.

LEHIGH VALLEY PLANS LARGEST PIERS IN THE WORLD

The first unit of the new terminal will replace the company's ore pier at Constable Hook, supplementing the company's pier at "National Docks" at Black Tom and Tide Water Basin Terminal in Jersey City. Cars will come to ship's side direct, provision being made on the piers which will be respectively 400, 550 and 350 feet wide for both storage and classification tracks. Slips between the piers will be 550 feet wide at the pier heads, tapering inshore to a minimum width of 450 feet. This feature is expected to facilitate handling of ships in and out of the slips, making it possible to navigate the slip channels while other vessels occupy berths on both sides.

The piers will carry large warehouses, open docks and storage space and will be fully equipped with traveling revolving gantry cranes and other mechanical freight handling machinery for handling heavy freight and for unloading ore. Pier No. 1, now under construction, will comprise an open

Fig. 5.—Pier Shed Showing Many Kinds of Freight to Be Handled

pier dock 720 feet long, an open storage space served by gantry cranes, a warehouse, and further outside an ore dock equipped with four unloaders for unloading ore from boats into cars at the estimated rate of one car per minute. Two 600-foot, 20,000-ton boats may be docked at one time at the unloaders, two at the warehouse and a fifth at the open dock. The open pier and warehouse docks are connected with the railroad receiving and storage yard having a capacity of 250 cars. A warehouse is being planned to provide for both storage and the classification of export and import freight.

Several original and interesting features in design are embodied in the new coal pier for the Western Maryland Railroad Company at Port Covington, Baltimore Harbor. The pier will be 792 feet long and 74 feet wide. Though differing in operation from either the electrically operated piers of the Pennsylvania Railroad Company or the Baltimore & Ohio Railroad Company in this harbor, electrical operation will be adopted throughout and the company's old power plant and steam operated barney abandoned. Situated on this pier will be erected the largest electrically operated coal dumper of this type in the world. The dumper, of steel construction, will stand approximately 118 feet high. It will have a loading capacity of twenty-five to forty huge 55-foot length, 110-ton coal cars per hour.

FUTURE PROSPECTS

Space does not permit a detailed description of the plans for many other ports that realize the need and advantage of port improvements and are planning well for the future. We could mention the plans of the Gulf ports of Mobile and Tampa; of another coal pier for the Virginian Railway at Norfolk; of the improvements to the Charleston waterfront; of terminal and industrial sites for Savannah; of improvements for Lake cities of Buffalo, Cleveland, Detroit, Chicago and Duluth. In fact, it seems the future has never held so many plans for port developments. A plan to rebuild every harbor and port along the Atlantic coast from Maine to Galveston and to install new freight handling machinery to do much work now done by men has been suggested in a resolution adopted by the Southern Traffic League at its recent meeting in Galveston. This would involve the expenditure of many millions and introduce machinery and labor saving devices.

A wise man profits by the experience of others. The latest constructed ports now operating show thought and clever engineering in their design. May the ports so vital to our country that are now planning and building be the outcome of the wise experience of the past, the best practice of the present and the hope and dream of the future.

Thornycrofts Launch Their Third Post-War Steamer

ON November 16, 1920, Messrs. John I. Thornycroft & Company, Ltd., launched at their Woolston shipyard their third cargo steamer within the past few weeks. This was the *Ville de Dannemarie,* building to the order of Messieurs Le Groupement Industriel de Charbons et de Transports, Rouen, France. The vessel, which was designed by her builders, is of the firm's standard well deck with raised quarter deck type. Her principal dimensions are: Length between perpendiculars, 240 feet; breadth, molded, 36 feet; depth, molded, 18 feet 6 inches; draft, 16 feet 9 inches, and her deadweight tonnage about 2,000. She is built of mild steel to Lloyd's requirements for a 100 A-1 class cargo steamer. The vessel's two cargo holds, one forward and the other aft, contain a combined capacity of 90,000 cubic feet, while coal bunkers for 150 tons are also provided. Water ballast is carried in the cellular double bottom and in fore and aft peak tanks.

PROPELLING MACHINERY

The propelling machinery, constructed in Messrs. Thornycroft's engine works, consists of triple expansion engines having cylinders 18 inches by 30 inches by 50 inches diameter by 33 inches stroke, developing 900 indicated horsepower and giving the ship a speed of 9½ to 10 knots. Steam is generated in two Scotch boilers each having two furnaces. These boilers are each 10 feet 6 inches in length, 13 feet 2 inches in diameter, and provide a working pressure of 180 pounds per square inch. The 7½-inch circulating pump is supplied by Messrs. Drysdale. The general service pump and the auxiliary feed pump, each 6½ inches by 4½ inches by 6 inches, supplied by Messrs. Carruthers, are of the duplex type, while the Mumford duplex ballast pump is 8 inches by 9 inches by 8 inches.

CARGO HANDLING EQUIPMENT

The cargo handling equipment consists of four 7-inch by 10-inch steam winches by Messrs. Rogers; two are placed in the forward part of ship and two aft. Four large cargo hatches equipped with eight 3½-ton derricks of pitch pine facilitate the rapid handling of the coal or general cargo which the ship is destined to carry.

Accommodation for the captain and officers is provided amidships, while that for the crew is arranged in the forecastle. It is expected that this ship will be completed and ready for delivery to her owners in about six weeks' time.

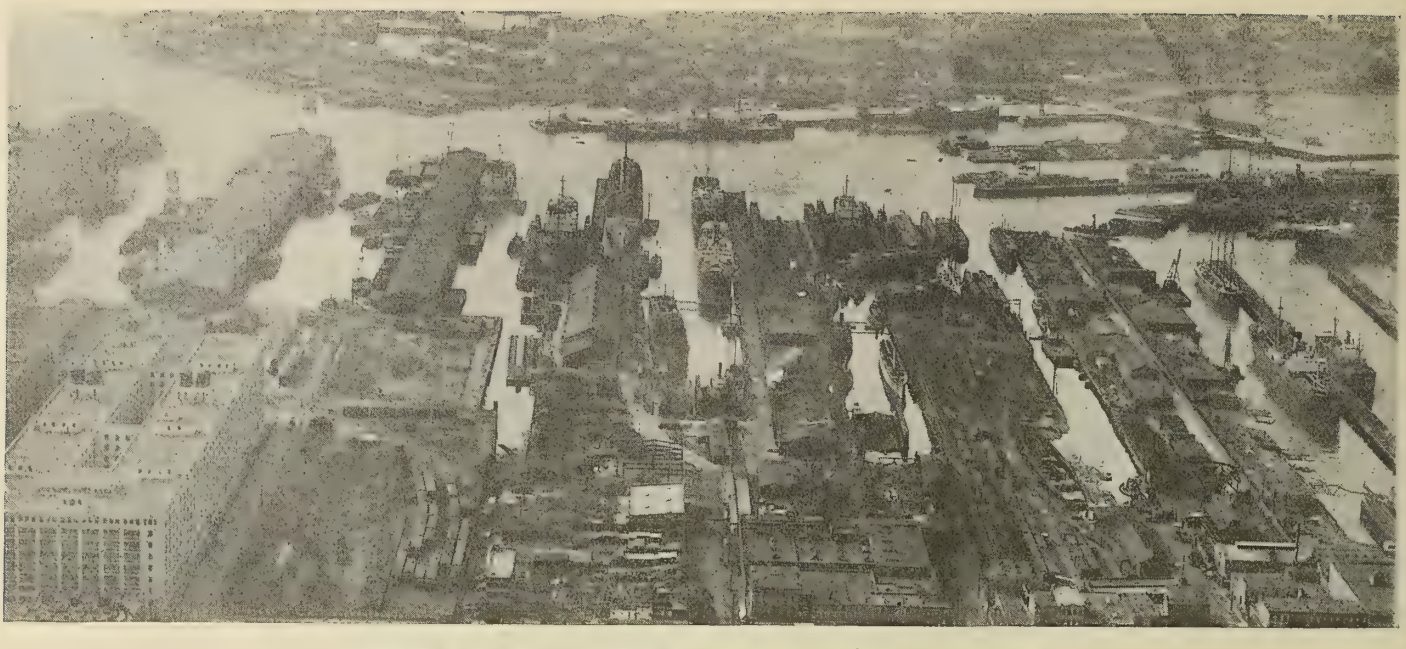


Fig. 1.—Repair Plant of James Shewan & Sons, Inc., Brooklyn, N. Y.

Ship Repair Facilities in the United States

A Summary of the Ship Repair Facilities Now Available for the Maintenance of the American Merchant Marine

ONE of the greatest lessons brought home to the people of the United States during the recent world war was the absolute necessity for the creation and development of an adequate merchant marine. The two basic requirements necessary for the construction and upkeep of a merchant marine are, first, shipyards, a well-known fact, and, second, an extensive and well-balanced system of repair facilities, a fact often lost sight of.

In the short space of three years the United States, aroused to action, has completed a shipbuilding programme that is without precedent in the history of the world and has placed itself in an admirable position to take over the share of the world's commerce to which it is entitled.

In view of the fact that the great fleet cannot maintain its efficiency for any length of time without ample provision for rapid dry docking and repairing, a study of the facilities for carrying on this work in the United States is considered timely and of the greatest importance. The following, therefore, is a summary of facts which result from a study of this kind.

Boston

Traveling south along the Atlantic seaboard from the northernmost point of the country, the first principal shipping port equipped with extensive repair facilities is the port of Boston, Mass.

There are seven ship repair yards in the vicinity of Boston equipped for repairing sea-going vessels. The largest of these is the Fore River plant of the Bethlehem Shipbuilding Corporation, Ltd., located at Quincy, Mass. The yard is fully equipped for undertaking repairs of the largest nature, the only limitation being bottom jobs which are limited to the capacity of a 10,000-ton floating dry dock.

New York

Traveling south from Boston, the next principal shipping port is New York. As New York is the principal seaport of the United States, it is only natural that repair yards abound in this locality. Such is the case, and no less than twenty-seven plants equipped for carrying out repairs to sea-going vessels are located in this vicinity.

Todd Shipyards Corporation

The Todd Shipyards Corporation, the largest ship repair organization in the world, maintains four repair plants in the vicinity of New York City, which are equipped for handling repairs of any magnitude. Of these there are three, the Robins Dry Dock and Repair Company, Tebo Yacht Basin Company and Clinton Dry Docks, Inc., located in Brooklyn, and one, Tietjen and Lang Dry Dock Company, located in Hoboken, N. J.

In addition to the above, the Todd Corporation maintains two yards on the Pacific coast, i. e., Todd Dry Dock and Construction Corporation, Tacoma, Wash., and Todd Dry Docks, Inc., Seattle, Wash.

The united resources of the Todd yards and plants comprise more than 200 acres of land and water equipped with the following facilities:

2 graving docks
19 floating dry docks
25 piers
110 shops
8 power plants
10 service vessels and floating equipment.

Each plant is a unit and every vessel obtains unit treatment precisely as if it were the only vessel in a yard devoted entirely to it.

The facilities of the Todd plants are complete to such a degree that no work is too great but that it can be undertaken and completed with dispatch.

Shewan Repair Yard

The largest single repair plant in the port of New York is that of James Shewan and Sons, Inc. This plant, which is located at the foot of 25th, 26th, 27th and 28th streets, South

Fig. 2.—Robins Plant of Todd Shipyards Corporation, Brooklyn, N. Y.

Fig. 3.—Tebo Yacht Basin Plant of Todd Shipyards Corporation, Brooklyn, N. Y.

Brooklyn, covers over 45 acres of land and water and is completely equipped as follows:

Boiler shop
Machine shop
Power plant
Air compressor plant
Pipe shop
Coppersmith, tinsmith and plumbing shop.
Electrical shop
Blacksmith shop
Saw mill, joiner, carpenter and pattern shop
4 floating derricks ranging from 10 to 40 tons capacity
4 ocean-going tugs for moving and shifting vessels
4 steam launches for taking workmen to vessels anchored in the stream
4 twin unit electric welding barges
2 air compressor barges
1 special barge for furnishing steam and applying water pressure to boilers
1 fully equipped fire boat

Ample berthing facilities are provided which allow forty vessels to be accommodated with a mean draft of about 35 feet.

The plant is surrounded by water piping to which a high pressure service is attached. These high pressure pumps are located on the pier and are automatically operated so that a water pressure of about 125 pounds is available at any point in the plant.

Large stocks of material for repairs are carried and 5,000 tons of plates and angles are kept on hand at all times.

Ten dry docks, ranging from 700 to 12,000 tons capacity, make this yard one of the most up-to-date and complete repair plants in the world and railroad sidings connecting with Bush stores and the Delaware, Lackawanna and Western Railroad, provide a ready means for handling stores and material direct to the work.

The Lord Dry Dock Corporation

Another large repair yard which promises to be an important factor in New York is that of the Lord Dry Dock Corporation. This company absorbed the business and equipment of the Weehawken Dry Dock Company in April, 1920, and since that time has been actively engaged in developing the 88 acres of plant involved along modern lines. This work is well under way and includes 2,000 feet of bulkhead, five 1,000-foot piers, and dry docks of capacities ranging from 1,000 to 10,000 tons.

Delaware River District

Moving south from New York along the Atlantic coast the next important shipping port is Philadelphia. Philadelphia is the center of what is known as the Delaware River district and there are 12 plants equipped for ocean-going ship repair work in this vicinity. The largest of these are the William Cramp and Sons Ship and Engine Building Company, Philadelphia, Pa., the Sun Shipbuilding Company, Chester, Pa., and the Bethlehem Shipbuilding Corporation, Ltd. (Harlan plant), Wilmington, Del. These yards are fully equipped for undertaking major repairs of any description except bottom jobs exceeding the capacity of their dry docks as given in Table I.

Fig. 4.—Lord Dry Dock Corporation Plant in Process of Construction at Woodcliff, N. J.

Chesapeake Bay District

The next important shipping center south of Philadelphia is what is known as the Chesapeake Bay district with Baltimore and Norfolk as the principal seaports. Ten repair yards are located in this district with facilities for repairing and overhauling large sea-going ships. The largest of these are as follows: The Newport News Shipbuilding and Dry Dock Company at Newport News, Va.; Baltimore Dry Docks and Shipbuilding Company, which maintains three repair plants at Baltimore, Md.; the Globe Shipbuilding and Dry Dock Company at Baltimore; the Sparrows Point plant of

the Bethlehem Shipbuilding Corporation, Ltd., at Sparrows Point; the Union Shipbuilding Company at Baltimore. The above yards are exceptionally complete in every respect and possess, with the exception of bottom jobs on vessels exceeding the capacity of their dry docks, facilities which enable them to undertake repairs of any nature on the largest ships afloat.

South Atlantic District

South of the Chesapeake Bay district there are two principal seaports along the Atlantic coast which boast of ship repair plants with docking facilities for average size vessels. These are Charleston, S. C., and Jacksonville, Fla.

The Charleston Dry Dock and Machine Company maintains an exceptionally complete repair plant located on the Cooper River at Charleston, S. C. There is an ideal bay at this point, and this, coupled with the fact that there is 30 feet depth of water, makes this an important yard. Their largest dry dock is one of the floating type of 8,500 tons capacity.

At Jacksonville the Merrill-Stevens Shipbuilding Corporation engages in the construction and repairing of steel vessels. The Merrill-Stevens Corporation is well equipped for doing major repairs and is also located on deep water. There are two dry docks operated by this corporation, one of 4,500 and the other of 6,500 tons capacity.

Gulf District

The Gulf district is well served with 10 repair yards located along the Gulf of Mexico from Key West to Galveston. The largest of these are as follows:

The Bruce Dry Dock Company, Pensacola, Fla.

Alabama Dry Dock and Shipbuilding Company, Mobile, Ala.

Jahncke Dry Dock and Ship Repair Company, Inc., New Orleans, La.

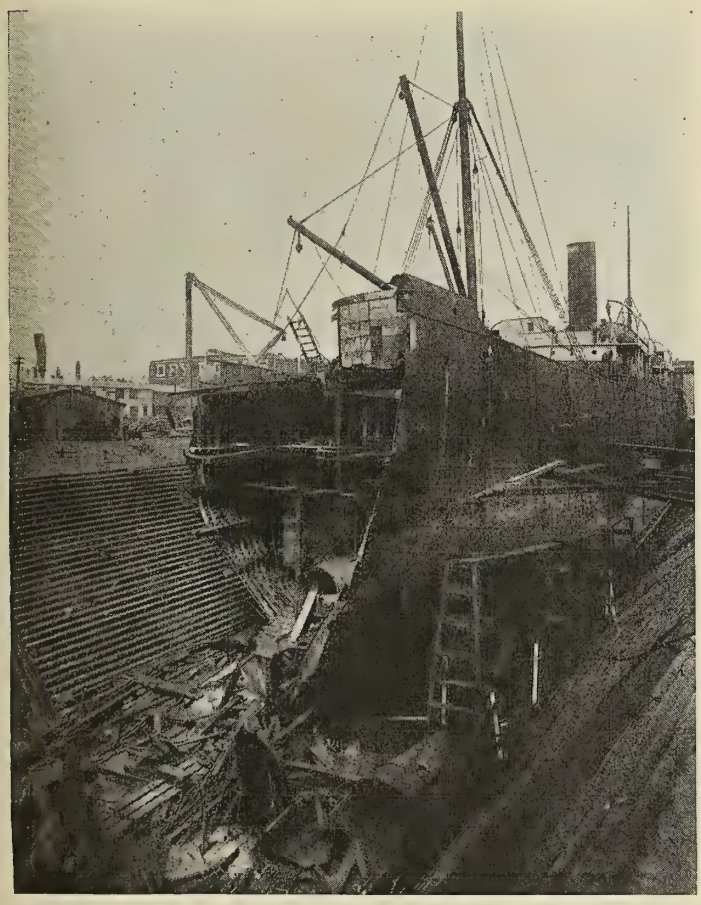


Fig. 5.—Rebuilding Damaged Vessel at Robins Dry Dock

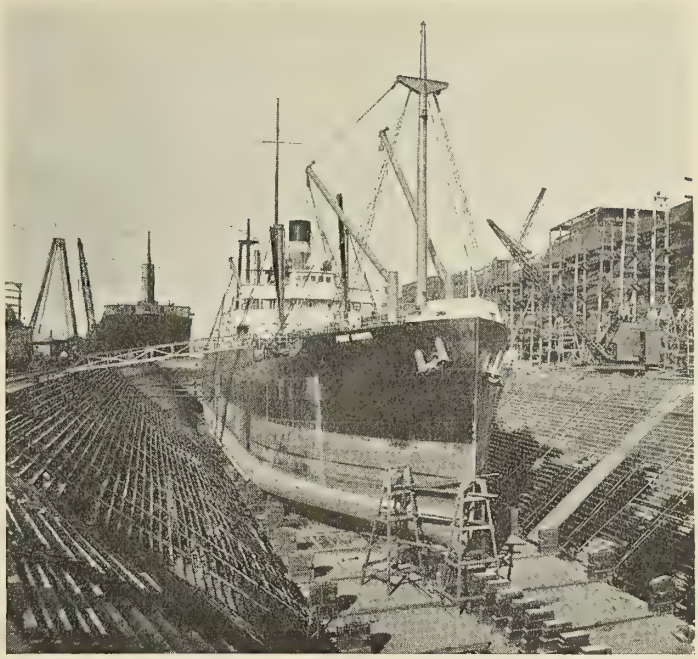


Fig. 6.—Pacific Mail Steamship *Point Bonita* Undergoing Repairs in the Lower Dry Dock, Baltimore Dry Docks & Shipbuilding Company

Johnson Iron Works, Dry Dock and Shipbuilding Company, Inc., New Orleans, La.

Galveston Dry Dock and Construction Company, Galveston, Texas.

The above yards are equipped for undertaking major repairs on the average size sea-going vessel, the Alabama Dry Dock, Jahncke Dry Dock and Galveston Dry Dock companies having dry docks up to 10,000 tons capacity, the Bruce Dry Dock Company up to 6,000 tons, and the Johnson Iron Works up to 5,000 tons.

South Pacific Coast

On the Pacific coast the southernmost repair district is the port of Los Angeles. The largest yards in this district are the Los Angeles Shipbuilding and Dry Dock Company, of San Pedro, Cal., which maintains a 12,000-ton floating dock, and the Long Beach Shipbuilding Company, of Long Beach, Cal., which operates a 3,500-ton floating dock.

San Francisco

North of the port of Los Angeles the next principal district is that of San Francisco. San Francisco is the principal seaport on the Pacific coast and there are four large and complete repair plants in this locality which are in a position to undertake repairs of any magnitude. These are the Barnes and Tibbitts Shipbuilding and Dry Dock Company, of Alameda, Cal., the Union plant of the Bethlehem Shipbuilding Corporation, Ltd., of San Francisco, Cal., the Hanlon Dry Dock and Shipbuilding Company and the Moore Shipbuilding Company, of Oakland, Cal.

Seattle District

The next district, north of San Francisco, with extensive ship repair facilities is known as the Seattle district. In this locality the largest repair plants are the Todd Dry Dock and Construction Corporation at Tacoma, Wash., and the Todd Dry Docks, Inc., at Seattle, Wash. There are no dry docks at the former yard, but the Todd Corporation maintains and operates three at the latter, there being one of 4,000 tons and two of 12,000 tons capacity each.

Great Lakes District

There is one more section of the country in which are located some large and up-to-date repair plants, and this is known as the Great Lakes district. The Great Lakes form

an important link in the transportation scheme of the United States and many thousands of tons of shipping are carried annually over these waters in vessels ranging up to 600 feet in length and 12,000 tons deadweight carrying capacity.

The American Shipbuilding Company is the largest ship repair company operating on the Lakes and maintains seven plants containing a total of 15 dry docks. These are located at Cleveland, Ohio; Lorain, Ohio; Detroit, Mich.; Chicago, Ill.; Buffalo, N. Y.; Milwaukee, Wis., and Superior, Wis.

Another of the larger organizations on the Lakes is the Great Lakes Engineering Company. This company owns and operates two repair plants, one being located at Ashtabula, Ohio, and the other at River Rouge, Mich. The former is equipped with a graving dock 600 feet long and the latter with two floating dry docks of 1,700 and 8,000 tons capacity respectively.

Other large repair companies equipped for making major repairs to large vessels are the Manitowoc Shipbuilding Corporation, of Manitowoc, Wis., and the Toledo Shipbuilding Company, of Toledo, Ohio.

In the outline given above the outstanding fact is that the United States is not only equipped to carry on the work of keeping its merchant fleet in repair, but that these plants are distributed in a manner that is highly satisfactory. Up-to-date yards fully equipped with modern appliances for carrying on ship repair work are already at hand, but as time is a very important feature in this work there is room for expansion, particularly in the matter of increasing the dry docking facilities.

The foregoing is a summary of the largest repair yards in the country equipped with dry docking facilities and able to undertake repairs of any nature. There are many more, however, which are in a position to do general repair work.

A complete list therefore of repair yards for ocean and lake service has been prepared and is presented in Table I, the information being divided by states and arranged alphabetically.

TABLE I.—SHIP REPAIR PLANTS OF THE UNITED STATES

Repair Plant and Location.	Marine Railways. Capacity in Tons.	Floating Dry Docks. Capacity in Tons.	Graving Docks. Dimensions	Shops.	Specialize in Repairs to
Alabama					
Alabama Dry Dock & Shipbuilding Company, Mobile	1,200 200	10,000 3,400 980 428		Machine Shop. Plate & Boiler Shop Welding Shop. Woodworking Shop. Paint Shop. Electric Shop. 20-ton floating derrick, 2 electric welding barges.	Steel ships up to 12,000 tons
Henderson Shipbuilding Company, Inc., Mobile	3,000			Machine Shop. Boiler Shop. Blacksmith Shop, Foundry, Pattern Shop, Woodworking Mill, Electric and Acetylene Welding and Cutting Plant.	General repairs steel and wood ships.
Kelly Dry Dock & Shipbuilding Company, Mobile	2,000			Machine Shop, Acetylene and Electric Plant.	General repairs steel and wood ships.
Murnan Shipbuilding Corporation, Mobile.	800			Blacksmith Shop.	General repairs steel and wood ships.
California					
C. L. Arques, San Francisco	1,200 600				General repairs dredges, barges, lighters.
Banning Shipyard, San Pedro	250				General repair work.
Barnes & Tibbitts Shipbuilding & Dry Dock Company, Alameda	4,000 2,500				General repairs.
Bethlehem Shipbuilding Corp., Ltd, Union Plant, San Francisco	Two to 4,000	Three to 10,000	1,096′ x 120′ x 40′ water O. S. 750′ x 103′ x 28′ water O. S.	Plate and Angle Shop, Planing Mill, Boiler Shop, Bolt Shop, Machine Shop, Brass Foundry, Iron Foundry, Pattern Shop, Sheet Metal Shop, Galvanizing Shop.	Steel ships.
Bowes & Andrews, San Francisco					Wood ships.
Cookson & Callahan, San Pedro					Wood ships.
Crowley Launch & Tugboat Company, East Oakland	600 300				Tugs and barges.
Fellows & Stewart, Inc., Wilmington	600 300 75				Wood ships.
Hanlon Dry Dock & Shipbuilding Company, Oakland	5,000			Equipment Repair Shop, Plate Shop, Machine Shop, Blacksmith Shop.	Steel ships.
Long Beach Shipbuilding Company, Long Beach		3,500		Machine Shop, Foundry, Coppersmith and Pipe Shop, Pattern Shop, Mold Loft, Plate Shop, Smith Shop, Joiner Shop.	Steel ships.
Los Angeles Shipbuilding and Dry Dock Company, San Pedro		12,000		Blacksmith Shop, Sheet Metal Shop, Paint Shop, Welding Shop, Planing Mill, Pattern Shop.	Steel ships.
Moore Shipbuilding Company, Oakland	7,000 7,000 6,000	20,000		Plate, Shop, Machine Shop, Blacksmith Shop, Mill, Angle Shop, Boiler Shop.	Steel ships.
Rolph Shipbuilding Company, Rolph				Boat Shop, Mold Loft, Paint Shop, Blacksmith Shop.	Wood ships.
San Diego Marine Construction Company, San Diego	200 200 200				Boats to 150 feet.
Stone & Son, Oakland					Wood ships.
Terminal Ways & Machinery Company, Long Beach					Wood ships.
Twigg & Sons, San Francisco	90				Yachts and barges.
Union Construction Company, Oakland				Carpenter Shop, Pipe Shop, Machine Shop, Foundry, Plate Shop.	Steel ships.

TABLE I.—SHIP REPAIR PLANTS OF THE UNITED STATES.—Continued.

REPAIR PLANT AND LOCATION.	MARINE RAILWAYS. CAPACITY IN TONS.	FLOATING DRY DOCKS. CAPACITY IN TONS.	GRAVING DOCKS. DIMENSIONS	SHOPS.	SPECIALIZE IN REPAIRS TO
Connecticut					
Connecticut Ship & Construction Company, New Haven	350				Tugs and barges.
Dauntless Shipyard, Inc., Essex	M. R. 125 feet long				Wood to 100 feet.
Miller Yacht Yard, South Norwalk	40 40 40 40 40			Machine Shop.	General repairs, yachts.
Ship Construction & Trading Company, Stonington				Paint Shop, Saw Mill, Blacksmith Shop, Pipe Shop, Planing Mill, Mold Loft, Joiner Shop.	Wood ships.
Thames Tow Boat Company, New London	3,000 1,000				General repairs tugs and barges.
Delaware					
American Car & Foundry Company, Wilmington	1,000 600				General repairs wood ships.
Bethlehem Shipbuilding Corp., Ltd., Harlan Plant, Wilmington			330′ x 40′ x 12′ water O. S.	Completely Equipped Plant.	Steel ships.
Delaware Shipbuilding Company, Seaford	One M. R.				Wood ships.
Florida					
Avery & Roberta Marine Ways Company, Inc., St. Petersburg	400 400				Wood ships.
The Bruce Dry Dock Company, Pensacola		5,000 1,200			Steel and wood ships.
Gibbs Gas Engine Company, South Jacksonville		1,000			Steel ships to 250 feet.
McCoy Bros., Holly Hill	175				Yachts.
Merrill-Stevens Shipbuilding Corp., Jacksonville	750	6,500 4,500		Fabricating Shop and Mold Loft, Carpenter Shop, Joiner Shop, Paint Shop, Tin and Coppersmith Shop, Plumbing Shop, Rigging Shop, Electric Shop, Machine Shop.	Steel ships.
Tampa Dock Company, Tampa	2,500			Machine Shop, Woodworking Department	Steel ships.
Tampa Steam Ways Company, Tampa	800 500				Wood ships.
Warren Fish Company, Pensacola	300				General repairs.
Wm. Curry Sons Company, Key West	1,000 500				General repairs.
Georgia					
Brunswick Marine Construction Corp., Brunswick	900				General repairs.
Southland S. S. Company, Savannah				Machine Shop, Mold Loft, Smith Shop, Paint Shop, Pipe Fitting Shop, Joiner Shop.	Steel and wood ships.
U. S. Maritime Corp., Brunswick				Machine Shop, Steel Shop, Wood Working Mill, Fabricating Shop.	General repairs.
Wilkinson Machine Company, Savannah					General repairs.
Illinois					
American Shipbuilding Company, Chicago			570′ x 72′ x 16′ water O. S. 727′ x 90′ x 16′ water O. S.	Joiner Shop, Paint Shop, Mold Loft, Tin Shop, Pipe Shop, Blacksmith Shop, Machine Shop, Pattern Shop.	Steel ships.
Kraft Shipyard & Dry Dock Company, Chicago					General Repairs.
Lake Shipbuilding Company, Chicago	M. R.				Steel and wood ships.
Indiana					
Howard Shipyard & Docks Company, Jeffersonville	M. R.				River craft.
Louisiana					
Jahncke Dry Dock & Ship Repair Company, Inc., New Orleans		10,000 8,000 6,000			General repairs.
Johnson Iron Works, Dry Dock & Shipbuilding Company, Inc., New Orleans		5,000 2,000 250		Furnace Shop, Forging Shop, Machine Shop, Plate and Angle Shop.	General repairs.
Stern Foundry & Machinery Company, New Orleans					General repairs.
Maine					
Camden Yacht Building & Railway Company, Camden		700 300			General repairs.
Cumberland Shipbuilding Company, South Portland		2,500		Mold Loft, Carpenter Shop, Heavy Timber Mill, Blacksmith Shop, Saw Mill.	General repairs.
Job Shipyard Corp., Machias					Wood ships.
Noues Machine Company, South Portland					Machinery repairs.
Percy & Small, Inc., Bath					Wood ships.

TABLE I.—SHIP RFPAIR PLANTS OF THE UNITED STATES.—Continued.

Repair Plant and Location.	Marine Railways. Capacity in Tons.	Floating Dry Docks. Capacity in Tons.	Graving Docks. Dimensions	Shops.	Specialize in Repairs to
Maryland Baltimore Dry Docks & Shipbuilding Company, Baltimore	1,500 800		600′ x 62′ x 18′ water O. S. 437′ x 52′ x 16′ water O. S.	3 Plants, Completely Equipped.	General repairs.
Booz Bros., Baltimore	1,800				Wood ships.
Cambridge Manufacturing Company, Cambridge	150				Wood ships.
Chance Marine Construction Company, Annapolis	250 20			Planer Shed, Carpenter Shop, Saw Shed Machine Shop, Forge Shop and Mold Loft.	Yachts, tugs, barges.
Crisfield Marine Railways, Crisfield	M. R. 150 Feet				General repairs.
Davis & Son, Inc., Solomons	300				Wood tugs and barges.
Globe Shipbuilding & Dry Dock Company, Baltimore		500′ x 100′			General repairs.
McIntire & Henderson, Baltimore				Machine Shop and Boiler Shop.	Machinery repairs.
Bethlehem Shipbuilding Corp., Ltd., Sparrows Point Plant, Sparrows Point		20,000 6,000		Completely Equipped Plant.	Steel ships.
Smith & Williams Company, Salisbury	250			Planer Shed, Tin and Paint Shop, Machine Shop, Woodworking Shop.	Wood ships to 250 feet.
Union Shipbuilding Company, Baltimore	4,000				Steel ships.
Massachusetts Atlantic Works, Boston	2,000 1,000 500				Steel ships.
Bertelsen & Petersen Engineering Company, Boston					General repairs.
Bethlehem Shipbuilding Corporation, Ltd., Fore River Plant, Quincy		10,000		Completely Equipped Plant.	Steel ships.
R. Bigelow, Monument Beach	30 30 30				Yachts to 100 feet.
S. W. K. Brooks, Boston					Wood ships.
Brown Boat Yard, Taunton	100				Yachts.
Crowninshield Shipbuilding Company, South Somerset	5,000 1,000 25			Machine Shop, Blacksmith Shop, Saw Mill, Carpenter Shop.	General repairs steel and wood ships.
Richard T. Green Company, Chelsea	2,000 1,600 250				General repairs steel and wood ships.
New Bedford Dry Dock Company, Fairhaven	2,500 1,000				General repairs.
Rocky Neck Marine Railway Company, Gloucester	250				General repairs.
Simpson's Patent Dry Dock Company, East Boston			450′ x 81′ x 16′ water O. S. 255′ x 68′ x 15′ water O. S. 150′ x 44′ x 11′ water O. S.		General repairs.
Winnisimmet Shipyard, Inc., Chelsea	3,000				General repairs.
Geo. Lawley & Son Corp., Boston	500 60 35				Yachts.
Michigan American Shipbuilding Company, Detroit			367½′ x 74′ x 16½′ water O. S.	Forge Shop, Rivet Shop, Shape Shop, Plate Shop, Assembling Shop, Carpenter Shop, Mold Loft, Structural Shop.	General repairs.
Dachet-Carter Shipbuilding Company, Benton Harbor		One Dock 125′ x 24′		Mold Loft, Woodworking Shop, Machine Shop, Joiner Shop, Blacksmith Shop, Saw Mill.	Wood ships to 200 feet.
Great Lakes Engineering Works, River Rouge		8,000 1,700		Machine Shop, Iron Foundry, Carpenter Shop, Pattern Shop, Blacksmith Shop, Erecting Shop.	Steel ships.
Heckler Bros., Sault Ste. Marie	1,000				General repairs.
Lanzell Shipyard, St. Clair					General repairs.
S. C. McLouth, Marine City					General repairs.
Port Huron Shipyard, Inc., Port Huron			350′ x 50′ x 16′ water O. S.	Plate Shop, Angle Shop, Blacksmith Shop.	General repairs.
Minnesota Marine Iron & Shipbuilding Co., Duluth		350			General repairs.
New Jersey American Shipyard Company, Camden	2,000				General repairs.
Bethlehem Shipbuilding Corp., Ltd., Moore Plant, Elizabeth				Machine Shop, Forge Shop, Foundry, Plate and Angle Shop, Carpenter and Joiner Shop, Paint Shop, Pattern Shop.	Steel ships.

TABLE I.—SHIP REPAIR PLANTS OF THE UNITED STATES.—Continued.

REPAIR PLANT AND LOCATION.	MARINE RAILWAYS. CAPACITY IN TONS.	FLOATING DRY DOCKS. CAPACITY IN TONS.	GRAVING DOCKS. DIMENSIONS	SHOPS.	SPECIALIZE IN REPAIRS TO
Delaware Shipbuilding & Repair Company, Camden					General repairs.
The Elco Works, Bayonne	One M. R.				Yachts.
Federal Shipbuilding Company, Kearney		12,000		Mold Loft, Furnace Shop, Plate Shop, Joiner Shop, Machine Shop, Sheet Metal Shop, Forge Shop, Foundry, Rigging Loft, Paint Shop.	Steel Ships.
W. & A. Fletcher Company, Hoboken		8,500			Steel ships.
John H. Mathis Company, Camden	1,000			Machine Shop, Boiler Shop, Electric and Acetylene Welding Plant.	Tugs, Barges and Yachts.
The Lord Dry Dock Company, Weehawken	10,000	4,000 1,200 1,200 1,000 1,000			General repairs.
Morgan Engineering Company, Jersey City					General repairs.
New Jersey Dry Dock & Transportation Company, Elizabethport	2,500 540			Saw and Planing Mill, Joiner Shop, Pipe Shop, Plate and Angle Shop, Mold Loft, Paint Shop, Machine Shop.	General repairs.
Perth Amboy Dry Dock Company, Perth Amboy		10,000 2,500 2,000 1,000 500		Machine Shop, Boiler Shop, Blacksmith Shop. Utility boat equipped with towing, welding and air compressor apparatus.	General repairs.
John Swenson, Jersey City		1,000 400			Wood ships.
Tietjen & Lang Dry Dock Company (Todd Shipyards Corp.), Hoboken		7,000 4,000 1,500 1,200 800 600 600 400 300		Completely Equipped Plant.	General repairs.
Union Dry Dock & Repair Company, Weekawken		2,000 1,000 800 500			General repairs.
Vulcan Iron Works, Inc., Jersey City		Six docks ranging from 1,200 to 6,000 tons		Joiner Shop, Saw Mill, Pattern Shop, Blacksmith Shop, Electrical Shop, Pipe Shop, Plumbing Shop, Floating Repair Shop and Electric Welder	General repairs.
New York The American Shipbuilding Company, Buffalo			470′ x 62′ x 13½′ water O. S. 630′ x 81′ x 14½′ water O. S. 401′ x 47′ x 14½′ water O. S.	Carpenter Shop, Electric Shop, Rigging Shop, Paint Shop, Punch Shop, Saw Mill Machine Shop, Blacksmith Shop, Pipe Shop, Tin Shop, Brass Shop.	General repairs.
Brewer Dry Dock Company, Staten Island		6,000 1,200 800		Woodworking Mill, Boiler Shop, Blacksmith Shop, Machine Shop.	General repairs.
Buffalo Marine Construction Company, Buffalo					General repairs.
Ira Bushey & Sons, Inc., Brooklyn		7,500 1,500			General repairs.
Clinton Dry Dock, Inc. (Todd Shipyards Corp.), Brooklyn		9,000		Completely Equipped Plant.	General repairs.
Consolidated Shipbuilding Corp., New York	300 150			Carpenter and Joiner Shop, Mold Loft, Machine Shop, Blacksmith Shop, Saw Shed.	Yachts, tugs and barges to 200 feet.
T. A. Crane Sons Company, Brooklyn					General repairs.
C. M. Englis, Inc., Brooklyn					Wood ships.
Fyfe's Shipyard, Glenwood, L. I.	300 300 300				Yachts.
Glen Cove Shipyard, Glen Cove, L. I.	1,000				Yachts, tugs and barges.
Gokey & Company, Brooklyn	3,000 1,200 800				General repairs.
Greenport Basin & Construction Company, Greenport, L. I.	1,200 800 200 30				General repairs.
Greenport Ship Company, Greenport, L. I.	500 200 75				Yachts.
Haff's Marine Railways, Babylon, L. I.	100 100 100				Boats to 100 feet.
Hiltebrant Dry Dock Company, South Rondout		1,200 800			Tugs and barges.

TABLE I.—SHIP REPAIR PLANTS OF THE UNITED STATES.—Continued.

Repair Plant and Location.	Marine Railways. Capacity in Tons.	Floating Dry Docks. Capacity in Tons.	Graving Docks. Dimensions	Shops.	Specialize in Repairs to
Hutchinson Bros., Alexandria Bay	50				Yachts to 125 feet.
Robert Jacob, City Island	1,100				Yachts, tugs and barges.
Johnson Shipyard Corp., Mariners Harbor, S. I.		6,000 2,000		Mold Loft, Joiner Shop, Blacksmith Shop, Saw Shed, Planer Shed, Paint Shed.	General repairs.
Kyle & Purdy, Inc., City Island	500 500 100			Saw Mill, Paint Shop, Joiner Shop, Mold Loft, Furnace and Punch Shop, Machine Shop, Copper and Sheet Metal Shop, Forge Shop.	Yachts and tugs.
Kingston Shipbuilding Corp., Kingston	1,500				Wood ships.
Liberty Dry Dock & Repair Company, Brooklyn		4,000 2,000 1,000			Tugs and barges.
Frank McWilliams, Inc., Staten Island	2,000 1,100 1,000 600				Tugs and barges.
Morse Dry Dock & Repair Company, Brooklyn		30,000 15,000		Completely Equipped Plant. Floating equipment consists of 5 tugboats, 3 lighters, 2 welding barges, 2 launches.	General repairs.
National Dry Dock & Repair Company, West New Brighton	2,500 1,500 1,000				General repairs.
H. B. Nevins, Inc., City Island	100 75 50				Yachts.
New Baltimore Shipbuilding & Repair Company, New Baltimore	400				Wood ships.
New York Harbor Dry Dock Corp., Port Jefferson, L. I.	1,500 500				Steel and wood ships to 5,000 tons.
New York Harbor Dry Dock Corp., Rosebank, S. I.		12,000 10,000			General repairs.
New York Yacht, Launch & Engine Company, Morris Heights	60 40				Yachts.
Julius Peterson, Nyack	Six to 100′ long				Yachts to 100 feet.
Ramberg Dry Dock & Repair Company, Brooklyn					General repairs.
Robins Dry Dock & Repair Company, (Todd Shipyards Corp.), Brooklyn		21,000 7,500 6,000	510′ x 100′ x 18′ water O. S. 620′ x 85′ x 23′ water O. S.	Completely Equipped Plant.	General repairs.
Rochester Boat Works, Inc., Rochester	50				Wood yachts.
St. Lawrence Marine Railway Company, Ogdensburg	3,000				General repairs.
James Shewan & Sons, Inc., Brooklyn		12,000 7,000 6,250 3,500 2,500 1,500 1,000 1,000 700 500		Boiler Shop, Machine Shop, Power Plant, Electric and Air Compressor Plant, Pipe Fitting Shop, Coppersmith, Tin Smith and Plumbing Shop, Electrical Shop, Blacksmith Shop, Saw Mill, Joiner Shop, Carpenter Shop and Pattern Shop. 4 Ocean-going tugs, 4 steam launches, 4 welding barges, 2 air compressor barges.	General repairs.
Sound Machine Shop, Inc., Mamaroneck	125				Yachts and tugs to 75 ft.
Standard Shipbuilding Corp., Shooters Island	3,500			Plate and Angle Shop, Machine Shop, Blacksmith Shop, Boiler Shop, Pipe Shop, Pattern Shop, Joiner Shop, Electrical Shop, Air Compressor Shop, Mold Loft.	General repairs.
Staten Island Shipbuilding Company, Staten Island		10,000 3,500 800 800 400 400		Machine Shop, Boiler Shop, Saw Mill, Carpenter Shop, Mold Loft, Plate Shop, Furnace Shed, Iron Foundry and Brass Foundry.	General repairs.
Tank Shipbuilding Corp., Newburgh	500				Tugs and barges.
Tebo Yacht Basin Company (Todd Shipyards Corp.), Brooklyn		2 docks to 10,000		Completely Equipped Plant.	General repairs.
Tregarthen & Sons Company, New York		3,000 2,000 1,000			General repairs.
North Carolina Elizabeth City Shipyard Company, Elizabeth City	210 feet 110 feet				General repairs.
Geo. A. Fuller Company, Wilmington					Steel ships.
Hamme Marine Railway Company, Wilmington	1,500 100				Wood ships.
New Bern Marine Railway, New Bern	100′ x 25′				River craft.
Willis Marine Railways, Morehead City	200				Wood ships.

TABLE I.—SHIP REPAIR PLANTS OF THE UNITED STATES.—Continued.

Repair Plant and Location.	Marine Railways. Capacity in Tons.	Floating Dry Docks. Capacity in Tons.	Graving Docks. Dimensions.	Shops.	Specialize in Repairs to
Wilmington Marine Railway Company, Wilmington	1,000				General repairs.
Ohio American Shipbuilding Company, Cleveland			547′ x 65′ x 17′ water O. S. 450′ x 50′ x 16′ water O. S. 360′ x 50′ x 12¾′ water O. S.	Pattern Shop, Machine Shop, Foundry, Electric Shop, Tin Shop, Coppersmith Shop, Blacksmith Shop, Angle Iron Shop, Plate Shed, Pipe Shop, Woodworking Shop, Rivet Shop, Paint Shop, Boiler Shop.	General repairs.
American Shipbuilding Company, Lorain			586′ x 66′ x 14½′ water O. S. 736′ x 80′ x 14½′ water O. S.	Electric Shop, Saw Mill, Pipe Shop, Joiner Shop, Punch Shop, Rivet Shop, Forge Shop, Sheet Metal Shop, Copper Shop, Angle Furnace, Machine Shop, Plumbing Shop, Boiler Shop, Paint Shop.	General repairs.
Great Lakes Engineering Works, Ashtabula			600′ x 72′ x 16′ water O. S.	Sheet Metal Shop, Angle Furnace, Plate Furnace, Joiner Shop, Paint Shop, Black smith Shop, Machine Shop, Saw Mill.	Steel vessels
Lake Erie Dry Dock & Mill Company, Sandusky	400				General repairs tugs and barges.
James Sears, Toledo	300				General repairs.
Toledo Shipbuilding Company, Toledo			690′ x 96′ x 14½′ water O. S. 569′ x 80′ x 13′ water O. S.	Boiler Shop, Joiner Shop, Lumber Shop, Paint Shop, Machine Shop, Foundry, Pattern Shop, Blacksmith Shop.	General repairs.
Oregon Portland Shipbuilding Company, Portland	1,400 250				General repairs.
Pennsylvania Wm. Cramp & Sons Ship & Engine Building Company	3,000 1,000		433′ x 69′	Completely Equipped Plant.	Steel ships.
Dravoburg Dock & Construction Company, Dravoburg					Wood ships.
Elizabeth Marine Ways, Pittsburgh	1 M. R.	3 docks			River craft.
Philadelphia Ship Repair Company, Philadelphia		3,500 1,200			General repairs.
Sun Shipbuilding Company, Chester		1 dock 550′ long		Boiler Shop, Outfitting Shop, Paint Shop, Carpenter Shop, Assembling Shop, Fabricating Shop, Furnace and Angle Shop, Smith Shop, Machine Shop.	Steel ships.
Rhode Island Lord Dry Dock Corp., Providence	3,500				General repairs.
Narragansett Shipbuilding Company, Tiverton	800				General repairs.
F. S. Nock, East Greenwich	250				Yachts.
South Carolina Charleston Dry Dock & Machine Company, Charleston	1,700 500	8,500		Boiler Shop, Machine Shop, Pattern Loft, Forge Shop, Foundry, Woodworking Shed, Coppersmith Shop and Repair Barge with Electric Welding Outfit, Air Compressor, etc.	General repairs.
Tennessee Nashville Bridge Company, Nashville	2,500			Plate Shop, Forge Shop, Machine Shop, Assembling Shop.	Steel barges.
Texas Beaumont Shipbuilding & Dry Dock Company, Beaumont	2,600			Paint Shop, Mold Loft, Blacksmith Shop Copper Shop, Machine Shop.	General repairs tugs and barges.
The Direct Navigation Company, Houston	250′ x 50′				General repairs, ships to 600 tons.
Galveston Dry Dock & Construction Company, Galveston	1,200	10,000		Machine Shop, Blacksmith Shop, Plate Shop, Woodworking Shop, Air Compressor, Electric Welding Outfit.	General repairs.
Heldenfels Bros. Shipyards, Rockport	400			Mold Loft, Saw Mill, Blacksmith Shop.	Tugs and barges.
Seaboard Transportation & Shipping Company, Channel Dyke					General repairs.
Virginia Colonna Marine Railway Corp., Norfolk	4,500 1,500 750 500				General repairs.
Mathews Marine Railway, Williams Wharf	100				Wood vessels to 100 tons
Newport News Shipbuilding & Dry Dock Company, Newport News			738′ x 84′ x 30′ water O. S. 542′ x 50′ x 25′ water O. S. 509′ x 79′ x 24′ water O. S.	Completely Equipped Plant.	General repairs.
Norfolk Shipbuilding & Dry Dock Corp., Norfolk					General repairs.
Norfolk Marine Railway Company, Norfolk	1,000 750				General repairs.
Old Dominion Marine Railway Corp., Norfolk	2,000 1,000				General repairs.

(*Table continued on page* 94.)

Passenger Steamship Mount Clay

(*Concluded from page 22.*)

tain's dining saloon, which will be used by the main officers of the ship. The wireless house and the staterooms for the wireless operators are also on this deck, being abaft the after-boiler hatch.

On the upper deck forward will be found the upper dining saloon, with a capacity of 140 persons. This room is finished in paneled oak. On the after end of this deck will be found the women's sitting room, which is also done in paneled oak and is finished with built-in upholstered seats and portable furniture.

There is an emergency light set, situated in a steel house on this deck, which consists of a 17-kilowatt gasoline-driven generator. This is connected to the emergency light set, as well as the wireless apparatus, no batteries being used.

On the main deck forward will be found the crew's quarters, hospital, etc. The lower dining room with a seating capacity of 334 persons is finished in paneled oak on the sides and paneled overhead.

On the after-well deck will be found a barroom on the starboard side and a dispensary on the port side. These are fitted in the most up-to-date manner. The passengers on this deck are all accommodated in staterooms.

On the second deck will be found the berthing space for the steerage passengers in the large holds. These berths are all so arranged that cargo may be carried in this space if desired.

The Rich system of fire extinguishing and smoke detection has been installed, as well as a sprinkling system in various departments.

Life Saving Equipment

To provide lifeboat capacity for such a large number of persons carried required considerable planning, as there is such a small space available for this equipment. It was finally decided to install seven sets of Welin davits on each side of the vessel, these davits taking care of the following boats:

One 24-foot standard motor Welin lifeboat; one 24-person standard Welin lifeboat; two 26-foot standard Welin lifeboats; ten 28-foot standard Welin lifeboats; fourteen 28-foot Broady 2-a lifeboats.

These provide for 1,613 persons. In addition to the above there are also fitted two, 25 persons each, cylindrical life rafts, taking care of a total of 1,663 persons, which includes 1,452 passengers and 211 crew.

The vessel has a draft of 27 feet 8½ inches and a displacement of 15,200 tons. A double bottom ballast will carry 988 tons of salt water. The reserve feed tanks in double bottom will carry 234 tons of fresh water. The ship's fresh water tanks have a capacity of 285 tons of fresh water. The coal bunker capacity is 3,701 tons, at 42 cubic feet per ton.

Machinery

The vessel is driven by twin screws, each engine being of the following dimensions: 24.8 inches by 36.31 inches by 51.67 inches by 74.8 inches by 55.1 inches stroke. Each engine develops 4,000 indicated horsepower at 86 revolutions.

Boilers

There are two double ended boilers and three single ended of the Scotch type fitted with Morison furnaces. The double ended boilers are 16 feet 3 inches, outside diameter, 19 feet in length.

The two single ended boilers are 16 feet 3 inches outside diameter and 11 feet 6 inches long, and one single ended boiler 15 feet 3 inches outside diameter and 11 feet 6 inches long, which is used as a donkey boiler.

There are 27 furnaces. The grate surface for the single ended boilers is 72.32 square feet and 146 square feet for each of the double ended boilers. These boilers are supplied with the Howden forced draft system and worked at a pressure of 213 pounds.

Propeller

The propeller is of the built-up type, cast iron hub, and four bronze blades. The following are the particulars of this propeller:

Diameter, 17 feet 9 inches; pitch, 21 feet; projector area, 71.04 square feet; developed area, 90.68 square feet; disk area, 247.45 square feet; pitch ratio, 1.18; projected area divided by disk area, .22; developed area divided by disk area, .7.

Two spare blades are carried on board.

Condenser

The main condenser is of the surface type.

Dynamos are of a German make, direct current, compound engines with a rating of 110 volts and 100 kilowatts.

The ship is equipped with 11 winches: three 7¾ inches by 11⅞ inches, six 8 inches by 13⅞ inches, two 8½ inches by 7⅞ inches, the latter two being used as boat winches on the boat deck.

The windlass has 10-inch cylinders and 14-inch stroke.

Ventilation

The vessel throughout the steerage quarters is fitted with a forced ventilation system with a number of fans directly connected to ducts that exhaust to the atmosphere.

Pumps

Main Feed No. 1.—Weir's simplex, 14 9/16 inches by 24 inches by 10 5/16 inches.

Main Feed No. 2.—Weir's simplex, 14 9/16 inches by 24 inches by 10 5/16 inches.

Auxiliary Feed.—Vulcan duplex, 14 9/16 inches by 12 inches by 9¼ inches.

General Service.—Vulcan duplex, 14½ inches by 12 inches by 9 3/16 inches.

Line Feed.—4½ inches by 24 inches.

Evaporator Feed.—Navy Yard simplex.

Fresh Water No. 1 and No. 2.—Blake duplex, 4.5 inches by 3 inches by 4 inches.

Main Circulators.—Vulcan centrifugal, 11 3/16 inches by 9⅜ inches.

Distiller Circulator.—Simplex.

Ice Machine.—6¾ inches by 5 inches by 6 inches.

Brine.—Worthington duplex, 6 inches by 7 inches by 6 inches.

Bilge.—Vulcan duplex, 8 inches by 9 inches by 10½ inches.

Line Bilge.—6¾ inches by 24 inches.

Sanitary and Ballast.—Wheeler duplex, 7½ inches by 10¼ inches by 10 inches.

Stand-by Sanitary.—Worthington duplex, 6 inches by 4 inches by 6 inches.

Fire and Bilge.—Worthington duplex, 7½ inches by 11 inches by 7 1/16 inches.

Ind. Air Pump.—Blake duplex, 8 inches by 12 inches by 16 inches.

Auxiliary Circulator.—Vulcan centrifugal, 6 3/32 inches by 6 inches.

The Atlantic Coast Shipbuilders Association reports that there remain under construction in five different shipyards on the Delaware River 26 vessels for the United States Shipping Board. All of these yards are expected to complete their schedules by March 1, except the New York Shipbuilding Corporation, which has several combination passenger and freight ships that will not all be delivered before September 1.

General View of First National Marine Exposition

Second New York Marine Exposition

National Marine League Completes Plans for Third of the Series of Shipbuilding and Shipping Expositions

OPENING shortly before the inauguration of the new presidential administration, pledged to the support and upbuilding of the American merchant marine, the coming National Marine Exposition to be held at the Grand Central Palace, New York City, January 24-29, will illustrate and further the developments in maritime affairs which will end in the stability of the American merchant marine and success in its fight for a place in the supremacy of the seas. It will be the third marine show held in this country and will combine with the interest of the first and second a new force and optimism. The outstanding feature of the first New York show was the arousing of general public interest and the bringing of a great mass of American voters to a state of shipmindedness which will eventually take concrete expression in a voting voice for the betterment and protection of the American merchant marine. The second show, held in Chicago, a thousand miles from tidewater, brought home to the people of the middle west their close and immediate connection with America's carrying trade, and the practical advantages to them which would follow the opening up of this region.

The Chicago show was an invasion of a region which has never been considered sea-minded by the maritime interests of the east, and it is interesting to see that in the coming exposition the middle west is returning the compliment. Many firms which operate chiefly on the Great Lakes will install displays to demonstrate that practice proven on the Lakes can be effectively applied to the problems of the tidewater, particularly, of course, in regard to freight handling at terminals. This interchanging of ideas is one of the most important features of the expositions, for, above all, they serve as a point of contact, a meeting place of the manufacturer and the shipper, the shipbuilder and the ship operator, and the marine industry and the public, and as these groups get to know each what the other is doing a basis will be formed for partnerships of mutual benefit.

The main floor of the Grand Central Palace will be occupied largely by shipbuilders and American steamship lines,

the manufacturers of engines and life saving equipment. Walking about this floor, the visitor will first see how ships are built, the processes being illustrated by machinery in operation wherever size permits; then, a few feet further, he will see how they are equipped with the thousand and one pieces of essential gear, from turbines, steering engines, main engines both Diesel and steam, lifeboats, signalling and control devices, down to such minor but still all important items as piping, valves and cordage. Then a few aisles further on the visitor will see maps, panoramas and models illustrating how the ships are used when they are built and how repaired when damaged by accident.

The mezzanine floor is in some respects a repetition of the first. The features of this floor are specialties and inventions, ranging from submarine signalling devices through engineering features which insure the efficient operation of main and auxiliary power installation down to the latest devices added to galley equipment, sail making and advanced marine publications. Throughout the exposition the exhibitors will make an increased use of operative exhibits and pictures to drive home to visitors exactly what it is they make and how the devices and equipment operate. The maritime trade must sell the idea of overseas trade to the American people, and the exposition is a means of doing so.

The programme to be carried out during the exposition includes the discussion of problems pertaining to inland waterways, as well as to shipbuilders and ship operators.

An innovation at the National Marine Banquet to be at the Hotel Commodore, January 15, will be the transmitting of the dinner addresses by radio to all points within a radius of 300 miles. The dinner will be given in connection with the National Marine Exposition, under the auspices of the National Marine League. Frank C. Munson, one of the trustees of the League, and president of the Munson Steamship Line, will preside at the dinner. P. H. W. Ross, president of the League, Senator Wesley L. Jones of Washington, and Senator W. M. Calder of New York and other prominent men will be among the speakers.

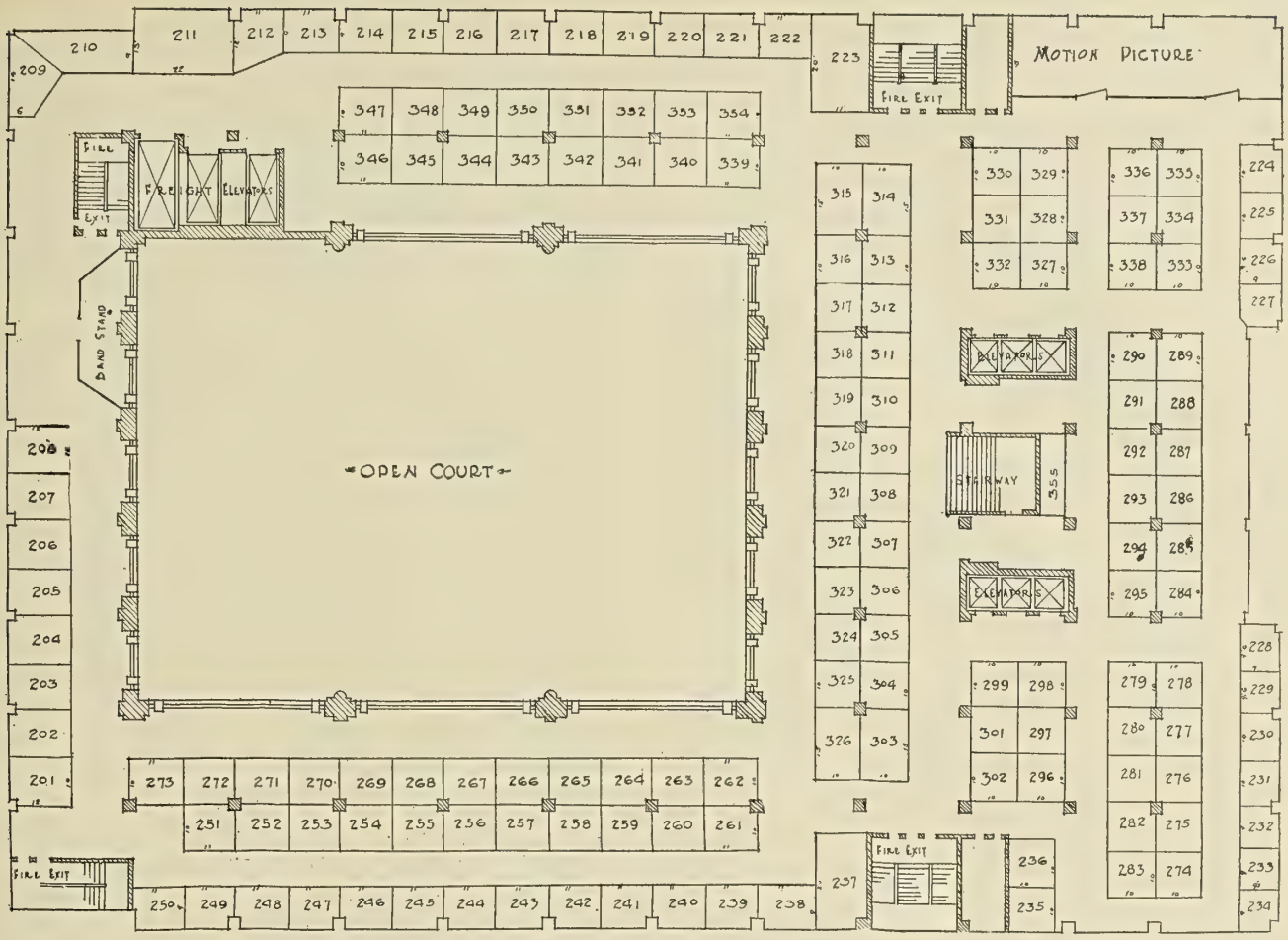
EXHIBITORS AT THE SECOND NEW YORK NATIONAL MARINE EXPOSITION

Main Floor

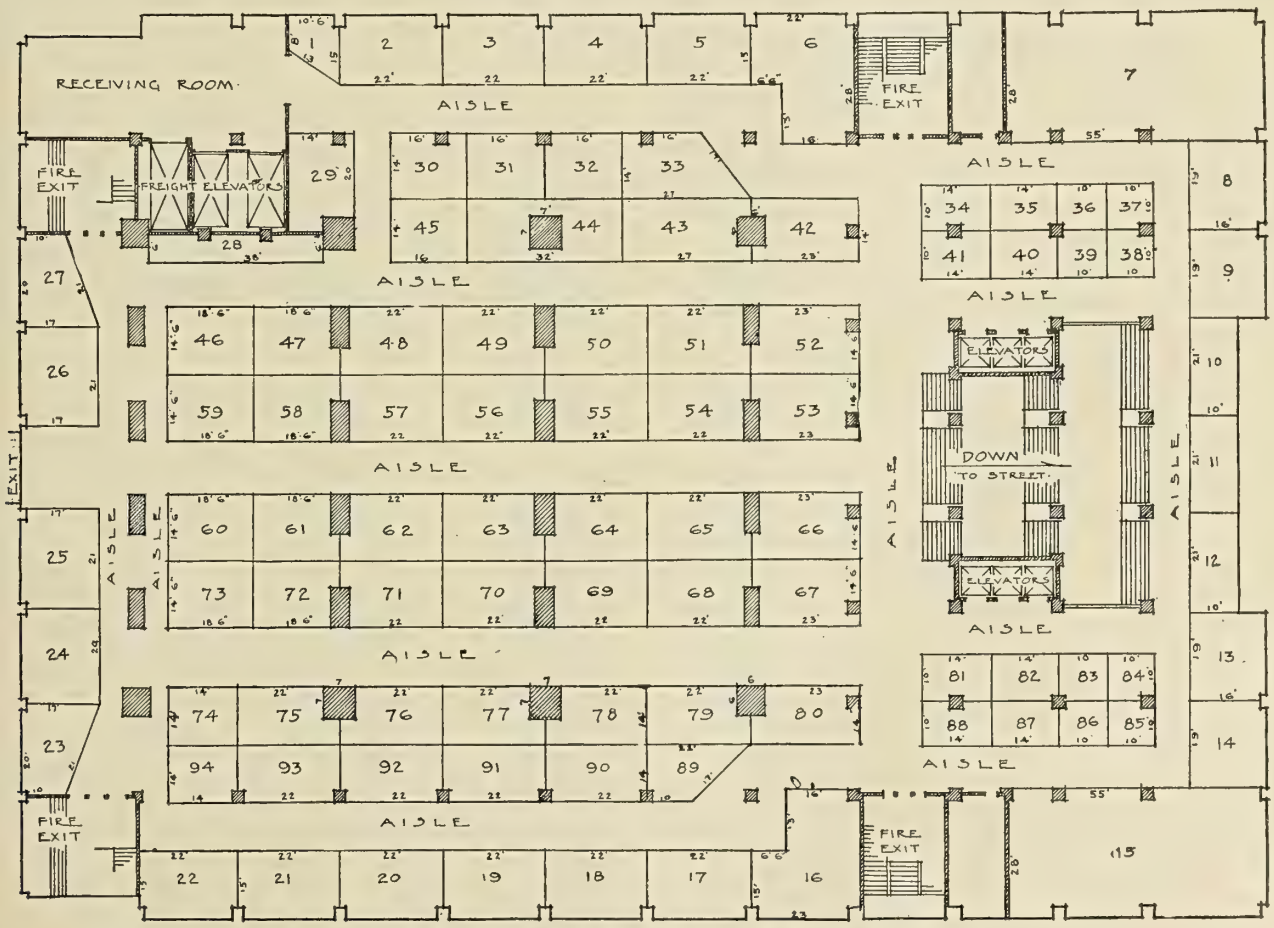
Exhibitors	*Booth Number*
American Balsa Company, 50 East 42d St., New York	19, 20, 21
American Car & Foundry Company, St. Louis, Mo.	65
American Engineering Company, Philadelphia, Pa.	17
American Manganese Bronze Company, Philadelphia, Pa.	29
American Manufacturing Company, Brooklyn, N. Y.	43
American Steel Foundries, Chicago, Ill.	36
Asbestolith Manufacturing Company, 1 Madison Ave., New York	38
Babcock & Wilcox Company, 85 Liberty St., New York	10, 11, 12
Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md.	55, 56
Bethlehem Shipbuilding Corporation, Bethlehem, Pa.	78, 79, 89, 90
Boucher, H. E., Manufacturing Company, 150 Lafayette St., New York	33
Brunswick Refrigerating Company, New Brunswick, N. J.	44
Coen Company, San Francisco, Cal.	9
Columbian Rope Company, Auburn, N. Y.	62
Cornell-Emery Company	75, 76
Cory, Chas., & Son, Inc., 290 Hudson St., New York	41, 34, 35
Crane Company, Chicago, Ill.	68, 69
Cutler Hammer Company, Milwaukee, Wis.	70
DeLaval Separator Company, 165 Broadway, New York	93
DeLaval Steam Turbine Company, Trenton, N. J.	91, 92
Electrose Manufacturing Company, Brooklyn, N. Y.	71
Fairbanks Morse & Company, Chicago, Ill.	45
Fuller, Geo. A., Company, Wilmington, N. C.	13
General Electric Company, Schenectady, N. Y.	4, 5, 6 and ½ of 3
Globe Shipbuilding Company, Baltimore, Md.	14
Gregory, Thos., Galvanizing Works, Brooklyn, N. Y.	28
Guarantee Exterminating Company, 400 Fifth Ave., New York	Part of 1
Hyde Windlass Company, Bath, Me.	16
International Mercantile Marine Company, 9 Broadway, N. Y.	46, 47, 58, 59
Irving Iron Works, Long Island City, N. Y.	74
Locomotive Superheater Company, 30 Church St., New York	48
Luckenbach Steamship Company, 44 Whitehall St., New York	87, 88
Lunkenheimer Company, Cincinnati, Ohio	94
Mallory Industries, Inc.	64
Maritime Engineering & Sales Corporation	37
Metal & Thermit Corporation, 120 Broadway, New York	39
Munson Steamship Line, 82 Beaver St., New York	83, 84, 85, 86
National Hoisting Engine Company, Harrison, N. J.	94
Niles-Bement-Pond Company, 111 Broadway, New York	40
Quasi-Arc Weldtrode Company, Inc., 109 Lafayette St., New York	93
Pacific Mail Steamship Company, San Francisco, Cal.	32
Plymouth Cordage Company, North Plymouth, Mass.	63
Reid, John, & Company, 30 Church St., New York	18
Shepard Electric Crane & Hoist Company, Montour Falls, N. Y.	30, 31
Sperry Gyroscope Company, Brooklyn, N. Y.	8
Steward Davit & Equipment Corporation, 17 Battery Place, N. Y.	66, 67
Sturtevant, B. F., Company, Boston, Mass.	26
Submarine Boat Corporation, 11 Pine St., New York	60, 61, 72, 73
Sun Shipbuilding Company, Chester, Pa.	Inside of 7
Thorsen, P. S., Company, 81 Coffey St., Brooklyn, N. Y.	77
Todd Shipyards Corporation, 15 Whitehall St., N. Y.	50, 51, 52, 53, 54, 55
United Marine Contracting Corporation	2 and ½ of 3
United States Mail Steamship Company, 45 Broadway, New York	22
Wall Rope Company, 48 South St., New York	42
Waterbury Company, 63 Park Row, New York	81, 82
Wheeler, C. H., Manufacturing Company, Philadelphia, Pa.	49
Whitlock Cordage Company, 46 South St., New York	80
Wilson Welder & Metals Company, 2 Rector St., New York	25
Worthington Pump & Machinery Corporation, 115 Broadway, N. Y.	½ of 15

Mezzanine Floor

Exhibitors	*Booth Number*
Aluminum Cooking Utensil Company, 1828 Broadway, New York	270
American Blower Company, Detroit, Mich.	321
American Chain Company, Bridgeport, Conn.	304, 305
Ashton Valve Company, Boston, Mass.	284
Atlas Soot Blower Company, 101 Park Ave., New York	345
Beaver Tile Specialty Company, 44 Cliff St., New York	213
Benjamin Electric Company, 243 West 17th St., New York	322
Benson Electric Company, Superior, Wis.	294
Bowman, M. K. Edson, Company, 65 Dey St., New York	241
Brown, A. Judson, & Company, 30 Church St., New York	298
Buzzini, Walter, Inc., 505 West 21st St., New York	282
C. H. Gillespie & Sons, 149 Broadway, New York	249
Campbell, G. W., 253 Broadway, New York	203
Columbian Bronze Corporation, 50 Church St., New York	342
Consolidated Shipbuilding Corporation, Morris Heights, N. Y.	268
Covel Manufacturing Company	301
Crane Packing Company, Chicago, Ill.	328
Cutting & Washington Radio Corporation, 6 West 48th St., New York	202
Davidson, M. T., & Company, 154 Nassau St., New York	326
Debevoise Company, 968 Grand Ave., Brooklyn, N. Y.	242
Devoe & Raynolds, Inc., 101 Fulton St., New York	214
Donnelly, Wm. T., 17 Battery Place, New York	257
Duparquet, Huot & Moneuse Company, 108 West 22d St., New York	240
Durkee, Chas. D., & Company, 2 South St., New York	250
Durkee Manufacturing Company, Staten Island, N. Y.	292
Edson Manufacturing Company, Boston, Mass.	316
Electric Arc Cutting & Welding Company, Newark, N. J.	201
Fire Detecting Wire Company, 2 West 45th St., New York	272
Foster Marine Boiler Corporation, 111 Broadway, New York	265
Gold Car Heating & Lighting Company, 17 Battery Place, New York	220
Goodrich Transit Company	343
Griscom-Russell Company, West Street Bldg., New York	277, 278, 279, 280
Hamilton & Hansell, 13 Park Row, New York	317
Hamlin-Healy Machine Co., 430 Eleventh Ave., New York	347
Hansen Yorke, Inc., 88 Warren St., New York	306, 307
Hartman, Chas., Company, 981 Dean St., Brooklyn, N. Y.	341
International Nickel Company, 43 Exchange Place, New York	312, 313
Jahncke Dry Dock & Ship Repair Company, New Orleans, La.	350
Kahnweiler's, David, Sons, 260 Front St., New York	269
Kelley Industrial Corporation, 37 Maiden Lane, New York	327
Kinney Manufacturing Company, Boston, Mass.	299
Lord Dry Dock & Construction Company, 105 W. 40th St., N. Y.	296, 297
Mack Engineering & Supply Company, 123 Liberty St., New York	251
Marine Canvas Supply Corporation, Pier 7, North River, New York	273
Marine Works, 3 Coenties Slip, New York	283
Marine Decking & Supply Company, Philadelphia, Pa.	293
Masten, George H., Company, 222 E. 46th St., New York	259
National Life Preserver Company, 11 Broadway, New York	212
Nautical Gazette, 20 Vesey St., New York	340
Nelson Looseleaf Encyclopedia	254
Neptune Association, 15 Park Row, New York	266, 267
Neptune Ship Supply Company, Inc., 73 Front St., New York	329
New Jersey Asbestos Company, 1 Water St., New York	227
New York Engineering Company, 2 Rector St., New York	324, 325
New York Marine News Company, 26 Water St., New York	295
New York Maritime Register, 88 Gold St., New York	204
Ocean Marine Engineers' Beneficial Assn., 15 Whitehall St.	336, 337, 338
Ocean Paint Works, 16 Whitehall St., New York	205
Paige & Jones Chemical Company, 15 E. 40th St., New York	311
Pantasote Company, 11 Broadway, New York	216, 217
Penton Publishing Company, Cleveland, Ohio	353
Pioneer Metallic Packing Company, 150 W. 25th St., New York	321
Pneumercator Company, 15 Park Row, New York	221, 222
Power Specialty Company, 111 Broadway, New York	264
Pyle National Company, The	237
Roberts Safety Boiler Company, 39 Cortlandt Street, New York	294
Roebling's, John A., Sons Company, Trenton, N. J.	323
Row & Davis, Inc., 90 West St., New York	209, 210
Schonberg, I., 122 Flushing Ave., Brooklyn, N. Y.	271
Scoville Manufacturing, Waterbury, Conn.	301
Sea Power	256
Shipping Publishing Company, 32 Broadway, New York	302
Simmons-Boardman Publishing Company, Woolworth Bldg., N. Y.	332
Smiths Port Publishing Company, 5 South St., New York	291
South Atlantic Ports Association	181, 219
Starke, Adolph, Estate of	248
Sternau Corporation, 9 East 57th St., New York	352
Sturrock Furnace Bridge Wall Company, 74 Cortlandt St., New York	290
Submarine Signal Corporation	314, 315
Texas Company, 17 Battery Place, New York	223
Thorne Manufacturing Company	330
Thorne Pioneer Company, 3 Atlantic Ave., Brooklyn, N. Y.	303
Tiebout, W. & J., Company, 118 Chamber St., New York	225, 226
Topping Brothers Company, 122 Chambers St., New York	252, 253
Traffic Service Bureau	281
United States Metallic Packing Company, Philadelphia, Pa.	228
Uttmark's Nautical Academy, 8 State St., New York	319
Valentine & Company, 456 4th Ave., New York	238, 239
Van Nostrand, D., Company, 8 Warren St., New York	318
Wager Furnace Bridge Wall Company, Inc., 149 Broadway, N. Y.	339, 354
Wailes, Dove, Hermiston Corporation, 17 Battery Place, New York	344
Ward Leonard Electric Company, Mount Vernon, N. Y.	206
Williams, D. T., Valve Company, Cincinnati, Ohio	227
William E. Williams, 62 Front St., New York	308, 309, 310
Wood & Chamberlain	258
Woolsey, C. A., Paint & Color Company, Jersey City, N. J.	245



Key Numbers to Exhibits on the Mezzanine Floor of the National Exposition



Layout of Exhibits on Main Floor of National Marine Exposition

Marine Engineering

Published Monthly by

ALDRICH PUBLISHING COMPANY

In Conjunction With

SIMMONS-BOARDMAN PUBLISHING COMPANY

6 East 39th Street and Woolworth Building, New York

F. B. WEBSTER, Editor
H. H. BROWN, Managing Editor
S. M. PHILLIPS, Associate Editor L. S. BLODGETT, Associate Editor
W. Z. GARDNER, *News Editor*

Contributing Editors

Rear Admiral C. W. Dyson, U. S. N.
Commander S. M. Robinson, U. S. N.
Professor C. H. Peabody
Captain C. A. McAllister, U.S.C.G. (Retired)
William Gatewood
H. McL. Harding
William T. Donnelly
James L. Bates

MARINE ENGINEERING is copyrighted and registered in the United States Patent Office. Copyrighted in Great Britain.

WE GUARANTEE that of this issue 9,500 copies were printed; that of these 9,500 copies 6,781 were mailed to regular paid subscribers, 370 were provided for counter and news company sales, 384 were mailed to advertisers, 79 were mailed to employees and correspondents, and 1,886 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 9,500, an average of 9,500 copies a month.

MARINE ENGINEERING is a member of the Associated Business Papers, Inc. (A. B. P.), National Association of Periodical Publishers, Inc., New York Business Publishers Association and the Audit Bureau of Circulations (A. B. C.).

Naval Policy

THE daily journals give prominence to the proposal to make the American Navy supreme; at the same time come reports that the British Admiralty proposes to defer additions to their fleet till after a study of the results of the recent war, that British statesmen are again proposing the "two nation" standard, that France is considering the construction of a huge submarine fleet and that Japan conditions her naval policy on that of the United States.

The war has left the British Navy supreme, and under the present financial stringency she may well take a look around before going ahead. If the "two nation" standard is held to, it today relates to her friends and allies, the United States and Japan.

Japan has had a phenomenal rise and has been shot forward into prominence by the abject surrender of the German fleet; her own statesmen, however, proclaim that she is not in condition to compete with either of the English speaking peoples. But her problems and her policy are her own and her statesmen have shown wisdom and foresight.

Our naval policy is now recognized to concern the whole nation—those who live on the prairies as well as those on the seaboards. Fortunately there is a general consensus of opinion that we must have a powerful navy and that our ships must be as good as the best; there never has been any question concerning the personnel and there never will be. We are committed to a large building programme; there is no opinion that the programme is excessive whether or not we join the League of Nations or whether there is any League of Nations.

But a race for supremacy between the United States and Great Britain is to be deprecated. Both nations are rich and both are stubborn. Each can well afford all the navy it needs; each can well consider first how much power it needs to ensure against any reasonable probability.

Ocean Liners and Passenger Ships

THERE is a world shortage of combination cargo and passenger vessels of the intermediate type. Shipping companies have been carrying on almost wholly with vessels that they have reconditioned since the armistice. Great Britain has a large number of intermediate liners under construction on the ways of the shipbuilding companies in that country with an indefinite prospect for work of this nature which is limited only by the cost of construction and date of delivery.

The excessive cost of vessels of the *Aquitania* and *Olympic* type, both as to construction and operation, has limited the present building to vessels of about 20,000 tons in size with large cargo carrying capacity and passenger accommodations of a comfortable but plain and non-luxurious character. This situation presents to America the very best inducement to try an active hand in the construction of passenger vessels. Twenty-six combination cargo and passenger vessels have been contracted for by the Shipping Board, some of which have been completed and the remainder are now under construction. The experience gained on these vessels and other passenger ships, together with the reconditioning of German liners, should place the American shipyards in a position to bid intelligently on such work.

Last spring and during the summer it was impossible to secure a passage on most lines unless booked far ahead, and there will be comparatively few new vessels available for next spring. With steel cheaper, labor-saving devices much more extensively used, and standardization of fittings, joiner work, etc., more highly developed, American shipowners and shipyards should get together with a view to securing the constructing of our share of passenger vessels in this country.

Prohibition on American Passenger Lines

THE enforcement of prohibition on American passenger vessels outside of the three mile limit will prove to be a severe handicap which our vessels will have difficulty in overcoming. A liner does a cosmopolitan and international business, and it is no more than right that we should respect those privileges of personal liberty that practically all countries outside of the United States consider proper. If the ocean belonged to the United States it would perhaps be different, but it belongs to one country as much as it does to another. So long as our ships have one or more of their terminals in a wet country the enforcement of prohibition aboard our vessels will not only be a financial loss to the American owners but the cause of numerous and perhaps serious misunderstandings, a condition to be deplored when we are striving to create good-will and better social relations.

If prohibition is put in practice on American vessels it can only be partially enforced on the outgoing voyage because wet countries cannot be expected to prevent people from carrying liquor aboard our vessels in their trunks. This condition of unrestrained drinking in staterooms would undoubtedly be much worse than the well regulated system of controlled distribution that now prevails aboard most ships. It is hardly too much to say that the result of the enforcement of prohibition on our vessels would drive many Amer-

icans as well as aliens to foreign liners, and that a large percentage of those who did travel on our liners would carry their liquor with them or buy it from some bootlegger on board. It is no more possible to enforce prohibition on one vessel when another running between the same terminals is wet than it was to keep one state dry while liquor was being sold by its neighbor.

The Load Line

It is earnestly hoped that the pending Load Line Bill will be enacted by Congress at the present session. This important measure has already passed the House of Representatives and is awaiting action by the Senate Committee on Commerce. The Secretary of Commerce, under whose jurisdiction the enforcement of the law will come, when passed, has already appointed a committee of experts to draft the necessary regulations under which the various types of vessels will have load lines affixed. This committee is presided over by Admiral D. W. Taylor, Chief Constructor of the Navy, who has to assist him as chairmen of sub-committees Professor G. R. McDermott of Cornell, Professor H. C. Sadler of Michigan and Professor W. F. Durand of Leland-Stanford. The other members of the advisory committee were selected from leading naval architects, shipowners and underwriters.

A preferential load line for oil tankers is being given serious consideration by the committee, because, among other things, the very nature of the cargo itself permits of rapid discharge into the sea, thus not only lightening the vessel but exerting a calming influence on the waves.

If it is difficult to agree on the regulation that should be put into effect regarding coastwise vessels, they could be exempted from the law for the time being, as they seldom go far from safe harbors and the records have not shown that many accidents have occurred in such vessels due to overloading.

The safety and welfare of our ocean-going merchant marine should be protected with a proper load line law at the earliest date, because, as the matter now stands, our vessels may be held up at any time in the harbor of any nation and re-surveyed to ascertain whether or not they are loaded according to the laws of that country. This may become a serious matter, particularly if the discriminatory measures of the Jones Bill are put into effect.

The Seamen's Act

President-Elect Harding in a recent speech stated that it was his belief that the Seamen's Act represented the American conscience in regard to the welfare of sailors, and that the United States ought to make good to the shipowners any deficiency that this Act imposed on the operating expenses. The principal objection on the part of shipowners to this law, however, is not the few extra men or the better quarters that the Act specifies, but the lack of control over the crew which the captain suffers due to the fact that under this law a sailor can quit a ship in any port by forfeiting one-half of the wages due him. Friends of the Act claim that this provision tends to equalize the wages of sailors all over the world and that when a foreign ship enters an American port a number of the crew generally desert, compelling the captain to hire a new crew at the prevailing American wages. Before the passage of the Act we were compelled to use our police powers to round up and return to our competitors any of their deserting crew that it was possible to find.

While it must be recognized that it will be impossible to obtain the right sort of American seamen if the living conditions and wages are unattractive as compared with those which may be obtained on shore, it is just as evident that our ships should not be compelled to undergo the expense and embarrassment of remaining in a port until a new crew can be found. Seamen as well as all other classes of men should be made to live up to their agreements, and in order to bring this about the penalty attached to desertion in the Seamen's Act should be made more severe.

Marine Insurance

Marine insurance makes it possible for shipping to offer the necessary security for financing its transactions. Shipping, banking and insurance interests should be encouraged to combine and co-operate with each other to the fullest extent, if our merchant marine is to secure its full share of international commerce. If foreign companies are allowed to handle the insurance business, they will acquire vital trade secrets which will be very useful to our competitors. They will know all about our shipments, who is sending and who receiving them, the trade routes of our vessels and the important terms of our commercial transactions.

The greatest obstacle in the way of the development of American marine insurance companies is the conflicting laws of the various states. In order to aid the forty-eight legislatures to secure the unity of action so necessary to the welfare of our country, a model marine insurance bill for the District of Columbia has been introduced in the House of Representatives by Congressman Edmonds. This bill was framed through the close co-operation of the Committee on the Merchant Marine and Fisheries and the Shipping Board after an exhaustive investigation of the whole subject and should form a basis for the states to follow.

The five fundamental ideas incorporated in the bill as interpreted by Dr. S. S. Huebner, expert in insurance for the Shipping Board and Committee on the Merchant Marine and Fisheries, are as follows:

"(1) Greater freedom on the part of American companies to co-operate through syndicates and mergers;

"(2) Establishment of the multi-field insurance principle, so that American fire, marine and fire-marine insurance companies may be free to transact all kinds of insurance other than life;

"(3) Substitution of a system of net profits taxation in place of the present system of taxing gross premiums;

"(4) Enlargement of reinsurance facilities, and

"(5) Removal of the limitations on the financial powers of companies which now hamper operations in foreign fields."

The legislative bodies of the forty-eight states should give the above principles their earliest consideration, and a failure to do so may result in the loss of the present opportunity of securing the adequate financial support so necessary to the development of our merchant marine.

LETTERS TO THE EDITOR

The First Electrically-Driven Passenger Ship

I have noticed in the December issue of MARINE ENGINEERING an article which claims that the first turbo-electric driven passenger ship is the S. S. *Cuba,* the General Electric Company having the distinction of furnishing the propelling machinery and the Morse Dry Dock & Repair Company of installing it. If the term "electric drive" may be applied to a turbo-electric propelling unit in which the power is transmitted from the motors to the propeller by means of mechanical reduction gear, I would call your attention to at least one passenger ship equipped with turbo-electric drive about two years ago. This vessel, the S. S. *Ragne,* now in service on the Baltic Sea, was built for Sveabolaget, of Stockholm, Sweden. The machinery was built by Svenska Turbinfabriks Aktiebolaget Ljungstrom, of Finspong, Sweden, and installed by Oscarshams Mekaniska Verkstads Aktiebolag, of Oscarshams, Sweden.

Trenton, N. J. GÖSTA HARTZELL,
Mechanical Engineer and Naval Architect.

Joint Packing on Fuel Oil Heater Line

Not long ago I had occasion to renew a joint on a fuel oil heater line at sea and on taking off the blown out joint I noticed that it was of millboard. No doubt the machinist or pipe fitter that made it up assumed that if millboard is all right on the cargo fuel oil line on deck it should be all right in the stokehold. The result was, however, almost a stop at sea. Steam packing is necessary where oil is carried under pressure, which I realize is nothing new to the old-timer, but there are many marine machinists on your subscription list who are new at the game.

I would also call attention to a little matter not generally known—the provision made for expansion on the top side of a main engine crosshead guide. When, in repair work, it is necessary to remetal the slipper, in making the "pin gage" the crank should be on bottom dead center, thereby eliminating possible error due to the allowance made by the builders in lining up the column.

JACK HARRINGTON.
Robins Dry Dock, Brooklyn, N. Y.

Filters in Lubricating Systems for Geared Turbines

On page 690 of your August issue is published a letter from Mr. Edwin M. May, district manager in New York for the Richardson-Phenix Company, which purports to correct a "gross" misstatement contained in an "article" by Messrs. Schmeltzer and Fernald in the June issue of MARINE ENGINEERING.* . . . If the circumstances attending the reprint of the paper had been more clearly defined there would have been little occasion for Mr. May to have criticised it in your columns.

Convention has generally limited the discussion of papers presented at a meeting of an engineering society to its own members or guests. Possibly, however, neither Mr. May nor any member of his company belong to the Society, or, if they are members, they may not have been present at the meeting, but under such circumstances the authors would themselves have been only too glad to have corrected any misstatement injurious to either an individual or a company, had the matter been called to their attention. Since the letter has been published I feel that Mr. May and your readers are entitled to a reply, if for no other reason than to point out that Mr. May's letter is predicated upon what seems to me to be an absolute misquotation of the statements in our paper as reprinted in MARINE ENGINEERING.

The second paragraph of Mr. May's letter reads as follows:

"I wish to direct attention to a gross and probably inadvertent misstatement which is made on page 510 in the paragraph entitled 'Filters and Separators.' In this paragraph mention is made of the fact that the centrifugal type of purifier is preferable because in the gravity filter the filtering elements, when placed in the gravity tank, will not function properly unless a sufficient head of oil can be obtained. Furthermore, due to the lack of this head, the oil will follow the line of least resistance and overflow without being filtered."

The paragraph on filters and separators published on page 510 of the June issue of MARINE ENGINEERING reads as follows:

"While all of the filters and separators specified are satisfactory for the purpose, it is considered that the results obtained from the centrifugal type of separator show greater efficiency, inasmuch as the oil, water and sediment are separated, the oil flowing from one nozzle, the water from another, the overflow mixture from another, and the sediment remaining in the bowl, from which it may be removed at will. Tests made at Annapolis prove that the rolling or pitching of a vessel will have no ill effects on its successful operation.

"Filtering elements placed in gravity tanks or in the discharge line from pumps to gravity tanks at its connection to gravity tank, unless at sufficient height above, cannot function properly, due to the lack of sufficient head, which results in the oil following the path of least resistance, i. e., through the overflow and not through the straining elements as intended."

Only by deliberate garbling could Mr. May have read from the paragraph in our paper the meaning contained in the second paragraph of his letter.

If the entire paper had been published it would have contained technical order No. 75, which amplifies the filter vs. separator problem. Paragraph 3 of Section "H" entitled "Strainers, Filters or Separators" reads as follows:

"Either a centrifugal separator, or a gravity filter of approved type, must be installed as indicated on Dr. E-11000-10 (Plate 4) with connection for oil supply to separator or filter through both gravity tanks and the reserve tank. The other connections required by the instruction sheet, accompanying the separator or filter, shall also be made. A centrifugal separator will be found especially effective in breaking up an emulsion of water and oil, even in a rough sea. The centrifugal separator can be either electric motor or steam driven. If turbine drive is used, the design should provide for operation against 10 pounds back pressure, so that the turbine can exhaust into the heater. The gravity filter, while effective in cleaning the oil, requires the heating and settling to break up an emulsion. Its effectiveness depends on the use of clean filter cloths. An ample supply of special lintless cloth should be carried on board and frequently changed."

I believe it will be immediately apparent to anyone who reads the above statements made by Mr. Schmeltzer and the undersigned that we expressed a preference for the centrifugal type separator primarily because of its ability to break up an emulsion of oil and water without preheating and settling. In other words, it is effective under sea conditions, which is not the case with any type of gravity filter known to us. Furthermore, the centrifugal separator was considered more convenient to install and operate. The authors of the paper still hold to the opinion that for marine use a good centrifugal separator is decidedly superior to any gravity filter.

The reference to filters placed in gravity tanks or the discharge line of pumps was entirely separated from the paragraph differentiating between filters and separators and had no connection with it. Before the Emergency Fleet Corporation, engineering section, gave attention to the lubricating

* The article in question, "Lubricating System for Geared Turbines," consisted of an abstract of a paper entitled "Standard Lubricating Oil Systems for Geared Turbines" read by Emile Schmeltzer and B. C. Fernald before the Society of Naval Architects and Marine Engineers in New York on November 14, 1919. This article was published in MARINE ENGINEERING by permission of the Society of Naval Architects and Marine Engineers and with full acknowledgment to the Society as the source of the material.—*Editor's Note.*

system of geared propelling turbines a number of vessels had been constructed in which an attempt had been made to filter the oil by placing filter cloth dams in the gravity tank between the discharge and outlet sides. It is manifest that in order to be effective a filter of this type would have to be capable of handling the entire oil flow of approximately 200 gallons per minute. As the size of the tank was proportioned with regard to the amount of oil to be stored rather than to its ability continuously to filter 200 gallons per minute, the filtering elements proved inadequate to function under the slight head possible with such installations and the filters in service proved to be practically inoperative, hence the comment in our paper in explanation of the rejection of this type of filter by the Emergency Fleet Corporation.

It seems hardly necessary to reply to the balance of Mr. May's letter, as it is not pertinent to his expressed desire to correct a "gross misstatement" in our paper.

New York. BENJ. G. FERNALD.

NEW BOOKS

Oil Fuel Burning

REVIEWED BY C. H. PEABODY, DR. ENG.

OIL FUEL BURNING IN MARINE PRACTICE. By J. W. M. Sothern. Size, 6 by 9 inches. Pages, 200. Illustrations, 102. New York, 1920: D. Van Nostrand Company; Glasgow, James Munro & Company.

This book is one of a series prepared by the author for use in his Marine Engineering College, Glasgow, which is maintained principally for young engineers who want to qualify for the higher licenses for seagoing marine engineers. These text-books are adapted for their purpose, giving what the aspirant needs to know and not cumbering him with abstruse details. The author says this work has been compiled by request to meet the demand of marine engineer officers for a book containing clear and exhaustive descriptions of various systems of oil burning, combined with general practical information and hints relating to the working of this modern method of steam raising, and he has shown discretion in his solution. He begins with a statement of the advantages and disadvantages of oil fuel, and goes on with such matter as chemistry of combustion, losses due to imperfect combustion and other matters which pertain more or less to all fuels. He gives the usual oil terms, flash point, firing point and viscosity and density, together with a description of instruments to determine these properties and goes into some detail of the use of such instruments. He gives useful tables such as specific gravity combined with the Baumé scale and the pounds per gallon, both British and American, also air velocity for certain drafts.

Having disposed of these introductory matters necessary for the understanding of oil burning, the author takes up various systems of oil burning individually in considerable detail. His method involves a good deal of repetition, but it has the advantage that each system may be read by itself and the engineers may give exclusive attention to the system he is using, if he desires to. Together with the description of the several systems are extensive folding plates and other illustrations necessary for understanding them. All the systems use mechanical sprayers, or they work on the pressure system. For each system a description is given of the burners, furnace mouth, furnace and bridge, method of air control, of pumping and of heating the oil. There are six methods described as used in Great Britain, and also the Babcock and Wilcox method. One of the six is used both in Great Britain and in the United States. For each method directions are given for the care of burners and other apparatus and for starting, running and stopping. The precautions given in connection with the Babcock and Wilcox method are worthy of mention; of course, they apply to any system.

Having discussed the various systems, the author tabulates the various faults that may be found in burning oil due either to lack of information or proper care, together with the consequences and the methods of detecting each fault. Following this there are given a large number of questions and answers to bring out the essential points of instruction and to allow the student to test his knowledge of the subject.

The work closes with general notes which summarize and present for ready reference the information given, together with certain matters not hitherto presented. In this chapter there is given at length the British Board of Trade instruction concerning arrangements and precautions for burning oil fuel.

Modern History of Warships

REVIEWED BY C. H. PEABODY, DR. ENG.

MODERN HISTORY OF WARSHIPS. By William Hovgaard, professor of naval design and construction, Massachusetts Institute of Technology. Size, 7 by 10 inches. Pages, 501. Illustrations, 209. E. and F. N. Spon, Ltd., London. Spon & Chamberlain, New York.

When arrangements were made nearly twenty years ago for special instruction to officers of the corps of naval constructors at the Massachusetts Institute of Technology, and after a curriculum had been prepared satisfactory to the chief constructor, Commander William Hovgaard, R.D.N., was invited to take the chair of naval design and construction at the Institute. Professor Hovgaard had special qualifications for this position, for in addition to his military training in the Danish Navy he had taken the course for naval constructors at Greenwich, England, and had served as manager of the shipyard of Burmeister and Wain at Copenhagen. A part of his work in the development of his subject is presented in this book; he has already published an important work on "Structural Design of Warships" and has now in press the "General Design of Warships."

A hundred years ago Great Britain had control of the seas and had built up an empire scattered all over the globe. At whatever sacrifice, she has maintained a navy competent to guard that empire; consequently, the history of naval development is a history first of the British Navy, and concurrently of other navies. Such was the order selected by the author in writing this work, with the further condition that he divides the time into periods marked by some notable change or development and in each period deals with the navies of the various countries. At first it is England and France and other countries; then England and Germany and other countries; now it is England and the United States and other countries. Not that the author formally proposes such a mode of procedure or that he adheres to it rigidly, but that the work naturally takes such a form. Since ships last many years, and since the changes do not take place simultaneously in all countries, the periods are not absolute, but the dates named are at least characteristic.

The first period, from 1860 to 1875, is more or less chaotic, marked by two tendencies—first, to put some armor on old types of ships, whether rebuilt or designed new, and, second, to make a new type of ship, namely, the monitor. It is convenient to remember that the original armored dreadnought, the archetype of all modern battleships, was a mastless breastwork monitor, a heavily armored ship with guns in turrets, and a ship with some pretense to seaworthiness.

Dissatisfaction with the breastwork monitor led to various trials in the next fifteen years to construct ships that should carry a few heavy guns and have good speed and seaworthiness. In this period the central battery ship and the barbette ship were developed; both types of ships were doomed as soon as a powerful secondary battery was accepted as a part of the offense of a battleship. Together with these ships

some ships of the breastwork monitor type were built of more satisfactory size, power and seaworthiness.

The modern battleship may be considered to date from the *Royal Sovereign* of 1890, especially for students who are interested in present conditions rather than in archeology. The class of ships of which this was the prototype was thoroughly worked out to fulfill all the conditions of service on any or all the seas of the world under the conditions then existing, especially as affected by ordnance, armor and speed. The design proceeded in an orderly manner, selecting first the battery, then the armor to protect the battery, and the buoyancy, and finally the power and the provision for ammunition and fuel. There was no attempt to put three pints into a great bottle, but sufficient displacement was assigned to make the ships entirely seaworthy and to provide proper height of the guns and wholesome quarters for officers and crew.

The battery consisted of four 13½-inch guns and ten 6-inch guns. When a satisfactory 12-inch gun had been developed that caliber was chosen for the main battery and remained the favorite until recent times. The displacement was 14,150 tons, then considered almost extravagant. This type of ship became the standard, and with modifications and increasing power and speed formed the first line of all important navies until the *Dreadnought* of 1906. The French placed each gun in its own turret and arranged armor in a different manner; the United States scrimped on size and sought for power by using heavier secondary guns, the 8-inch gun long being a favorite, and Germany, by limiting the radius of action and using 11-inch guns for the main battery avoided large displacement. In the competition for power, heavier guns were added to the secondary battery in the British and other navies, 9.2-inch and 10-inch guns being used either with or without smaller guns. The United States stuck to the 8-inch guns for almost all her ships.

The determining course of the latest development of battleships was the improvement in range finding and fire-control, and especially the perfecting of spotting to determine the effect of fire on the target. This demanded that all guns should have the same range, so that definite results could be had; also the perfection of these methods led to salvo firing, a return to the practice of the old wooden line-of-battle ships.

There is nothing new about giving a ship guns of a single caliber, nor about using the largest practicable caliber. When the Civil War opened, the 11-inch smooth bore gun was the heaviest available gun, and the policy was to give all ships that caliber. A ship might have few or many guns, but at least it could reply to fire from any source; but a ship that is outranged is lost—it does not need the experience of the recent war to establish this fact.

When the British Navy laid down the *Dreadnought* a new era opened and all ships already built were relegated to the second class. There was much criticism of the policy because all nations had a chance to begin even except as Great Britain had a slight advantage at the start. The *Dreadnought* carried ten 12-inch guns; the number on later ships by various nations has been increased to twelve or thirteen. Later, in the competition for power, the caliber has been increased to 14 inches and to 16 inches; the larger calibers have also some advantage in range. Various arrangements were devised to get the greatest effective fire in all directions. The United States took the lead in placing all turrets on the centerline and introduced the principle of setting some guns to fire over the adjacent turrets, also of putting three guns in a turret; but here France has gone farther, using four gun turrets. Our latest battleships carry twelve 16-inch guns in four turrets.

The armored cruiser has always been an anomaly because it is given high speed and good seaworthy qualities at the expense of either battery or protection. There are most important duties for the cruiser, and in carrying them out cruisers are likely to fight, in which case the ship which has the advantage in guns is almost sure to win by outranging the enemy, and protection, even though insufficient, is valuable. But usually an armored cruiser is a fast second-rate battleship, and a sound principle is that all battleships should be worthy to lie in the line.

The apotheosis of the armored cruiser is the battle cruiser, as big as a battleship, as fast as a destroyer and carrying a few guns of the greatest caliber. It is a misnomer to call such a ship a battle cruiser, for it is not fit to lie in the line, as shown by the loss of three British battle cruisers in the battle of Jutland when subjected to the fire of the German fleet. That the British battle cruisers gave them the command of distant seas at the Falkland Islands may justify the construction of such monstrous cruisers for a nation that can afford them. All of this, it is believed, can be justified from the facts given in the book under review. The author on page 227 expresses much the same idea where he demands that certain fast ships are required which should be battleships with as good armor protection, though not necessarily carrying so many guns.

The torpedo is a weapon of surprise and has seldom, if ever, been effective without surprise. The torpedo boat was originally a small, scarcely seaworthy, craft of high speed; its weapon was the torpedo, and its guns were few and feeble. But such a craft is a nuisance, and after various unsuccessful attempts at a reply the torpedo boat destroyer was evolved, being a big seagoing boat of the same type with good armament for its displacement. Then the torpedo boat disappeared and the new powerful boats were simply called destroyers, which is a good warlike name. The torpedo carried by battleships, cruisers or destroyers has for its most effective rôle the forbidding of close range action of large ships, but there are more effective influences forbidding close range action. The destroyer being able and swift has acquired all sorts of duties for which the gun is the primary weapon, as clearly shown by the author.

The author, who has given special attention to submarines, has an excellent chapter on the principles of construction and service of submarines. He divides the submarine into two classes of 600 tons or less for coast defence, and of 1,000 tons or more for sea service. The future is thus stated "with the advent of the steam-driven submersible cruiser of 3,000 tons or more, an entirely new development has been inaugurated, the end of which no one can foretell." He concludes: "The submarine is an important link in the naval defences, but the capital ship remains the supreme type of warship."

Aircraft as forming a part of navies is dealt with briefly; both dirigibles and airplanes or seaplanes are described. "Scouting is the service for which airships are best adapted," and the same remark applies to airplanes. As a weapon against ships they are feeble and uncertain and can hope for success only by surprise under most favorable conditions. Since the author already has a book on "Warship Construction," his chapter on this subject is properly brief. So is his chapter on engines, since he is not writing on marine engineering. His history of archaic engines hardly appears necessary in a book of this sort. His chapter on ordnance is sufficient to show the relation to the history of the warship, and the same can be said of his chapters on armor and on mines. Finally the author sums up the present situation, giving the characteristics for battleships, battle cruisers and other craft. An illuminating recommendation for minor navies is that they should abstain from battleships which they cannot afford and provide only for coast defence by aid of submarines, torpedo boats, air craft and mines.

Inventions, their development and sale, is the title of a book by William E. Baff, patent attorney, recently published by D. Van Nostrand Company, New York. This book is essentially a manual on the marketing of inventions and explains how inventions may be profitably exploited.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

CONDUCTED BY JAMES L. BATES

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

Tonnage Deduction for Machinery Space

Q. (1053).—Quite recently the question of the advantages and disadvantages of the two-cycle against the four-cycle Diesel engine for marine purposes has again been raised and dealt with in various papers. One of the advantages claimed for the two-cycle engine is its reduced length. But is this particular advantage of any value? If my memory serves me right, there is a ruling for the minimum length or cubic contents of boiler and engine room of a ship of a certain displacement, and I think that this minimum length is already reached with our standard four-cycle engines on large transatlantic motor vessels. I do not know whether any of the classification societies make such a restriction or whether it is on account of the way of measurement of registered tonnage, gross, net or underdeck tonnage that only a certain percentage of the total displacement is allowed to be deducted for the engine and boiler room for reasons of calculating the port charges, taxes, etc., on a fair basis. If there is any such restriction, what is the ruling on it? P. R.

A. (1053).—At present there is no fixed ruling as to the length of the machinery space for a cargo steamer. However, the floodable length method of determining the bulkhead spacing which has been suggested by the British Board of Trade and the International Convention for Safety of Life at Sea should be kept in mind, although intended primarily for passenger ships.

You are quite right in stating that if the tonnage of the machinery space reaches a certain percentage (13 percent of the gross tonnage) the deduction for obtaining the net register tonnage is greater than if it falls under this amount, as the following quotation from the tonnage rule indicates:

"The actual space enclosed by the engine room must be calculated and the percentage it bears to the gross tonnage determined to enable the allowance conceded by law to be made. Should this percentage be over 13 and under 20, an allowance of 32 percent may be deducted from the gross tonnage in computing the net register. Should, however, the actual engine room not exceed 13 percent of the gross tonnage, the allowance would then be the actual space plus three-quarters of same."

Hence as the tonnage rule now stands the question of volume of the machinery space should be considered, and it is perfectly possible that a two-cycle Diesel engine would not gain any advantage from its smaller size save in increased cubic capacity of the holds.

Strength of Propellers

Q. (1111).—Will you please inform me how the strength of propellers is figured and the reason for giving the blades a rake aft. J. A. W.

A. (1111).—Seaton's "Manual of Marine Engineering" gives the following formula for thickness of propeller blade:

$$\text{Thickness of blades at } 1\tfrac{1}{2}d \text{ from center} = \sqrt{\frac{I.H.P. \times f}{R \times n \times b}} \times K.$$

d = the diameter of screw shaft at propeller.
b = the breadth of blades in inches at a distance $1\frac{1}{2}d$ from the center of shaft.
n = the number of blades.
R = the number of revolutions per minute.
f = 100 for compound engines of the ordinary two cylinder type; 90 for three cylinder, compound, four crank, triple and quadruple engines; 85 for three crank, triple compound engines.
K = 4 for cast iron; 2 for ordinary gun metal; 1.6 for cast steel; 1.5 for forged steel and bronzes of high quality.

"For ships engaged in the North Atlantic or on other seas, where rough weather largely prevails, these factors may with advantage be increased by 20 or 25 percent. This is especially necessary for cargo vessels, which may often have to run 'light.'

"The thickness of metal at the tip should be .2 of that at the root."

For a somewhat more elaborate calculation, reference is suggested to the "Marine Engineers' Handbook" by Sterling, from which the following is largely taken:

T = thickness of blade, in inches (neglecting fillets), at its line of tangency to hub.
W = width of blade tangent to hub, in inches.
$A = 5{,}252\ I.H.P._a \div (R \times N)$.
$I.H.P._a$ = actual power required by actual propeller to deliver the effective (tow rope) horsepower of the vessel.
$e.h.p.$ = the net effective horsepower required for the actual speed in knots.
R = revolutions of the propeller per minute.
N = the number of blades.
$B = 0.31 \times$ diameter of the screw in feet $= 0.31D$.
$C = A \div B$.
$D = 12 \times B$ — radius of hub, in inches.
$E = c \times D$.

$$F = \frac{33{,}000 \times I.H.P._a}{(P \times R \times N)}.$$

$G = 0.345 \times$ diameter of propeller, in inches.
$H = G$ — radius of hub, in inches.
$J = F \times H$.
K = circumference of hub, in feet, $\div P$, in feet.
L = sine of arc whose tangent is K.
M = cosine of arc whose tangent is K.
$N = L \times J$.
$O = M \times E$.
$P = N + O$.
f = fiber stress as per values of $e.h.p. \div E.H.P.$ given in appended table.

$$T = \sqrt{\frac{13.125\,P}{W \times f}}.$$

$E.H.P.$ = basic effective (tow rope) horsepower.

For cast iron and semi-steel, f = 2,500 to 4,000 for values of $e.h.p. \div E.H.P.$ not in excess of 0.4.

For the strong bronzes, T should never exceed

$$\sqrt[3]{\frac{P \times 2.625}{f}}.$$

VALUES OF f TO BE USED FOR DIFFERENT DESIGN POINT VALUES OF $e.h.p. \div E.H.P.$

$\frac{e.h.p.}{E.H.P.}$	Values of f: Constant Torque, Manganese Bronze	Constant Torque, Cast Steel	Reciprocating Engines, Manganese Bronze	Reciprocating Engines, Cast Steel
0.1	4,800	4,300	4,800	4,300
0.2	5,500	4,900	5,400	4,850
0.3	6,300	5,750	6,000	5,500
0.4	7,150	6,650	6,550	6,050
0.5	8,000	7,500	7,150	6,650
0.6	9,000	8,450	7,750	7,250
0.7	9,800	9,300	8,300	7,800
0.8	10,750	10,250	8,900	8,400
0.9	11,600	11,100	9,450	8,950
1.0	12,500	12,000	10,000	9,500

In discussing the rake of propeller blades, Admiral Dyson,

in "Screw Propellers for Hydraulic and Aerial Propulsion," writes as follows:

"It is very common practice to rake the blades aft to a more or less degree, and this practice was generally followed in the United States Navy until a few years ago. There was a generally accepted idea that centrifugal action of the screw was decreased and that efficiency was increased by so doing.

"An examination of the performances of actual screws in service, and of model screws in the tank, shows that there is no solid ground for either belief. In the cases of the actual screws, no difference in the propulsive efficiencies of screws with and screws without rake can be noticed, and the models gave practically identical results. As to centrifugal action, numerous tank experiments have shown the propeller race to be almost cylindrical, and that so far from there being centrifugal action there appears to be a slight convergence abaft the propeller.

"An actual advantage gained by raking the blades aft is that the blade tips of wing screws are given greater clearance from hulls of usual form than if the blades were radial; also, for the same blade clearance the strut arms may be made shorter. Another advantage which the rake may have is in giving greater clearance between the leading edges of the blades and the after side of the stern post and struts, this additional clearance allowing the water a chance to enter the disk at a better angle."

On the other hand, "radial blades, in addition to being as efficient as those with rake, are more easily machined, have less total developed area for equal projected area, and therefore less surface friction, are stiffer and lighter; also, the stresses in the blades due to centrifugal action are less. With propellers of high speed of revolutions, this latter point is very important, and for such screws the blades should never rake."

The Baumé Scale

Q. (1114).—Will you please explain through your columns the relation between Baumé and Baumé hydrometers. Also give the formula for converting readings on the Baumé scale to specific gravity, the scale on the Baumé hydrometer being graduated in units on each side of the zero mark as 1-2-3-4, and each unit divided into quarters. Also please explain the reading of a salinometer. C. C. B.

A. (1114).—The French chemist, Antoine Baumé (1728-1804), devised and used the scales now known by his name in the graduation of hydrometers. There are two Baumé hydrometers. One is intended for use with liquids heavier than water. It sinks to 0 degrees in pure water and to 15 degrees in a 15 percent salt solution. The other is intended for use with liquids lighter than water. It sinks to 0 degrees in a 10 percent salt solution and to 10 degrees in pure water. The graduation in each case is based upon the distance between the points above noted and is carried out along the stem of the instrument to any desired distance.

The degrees in a Baumé scale are of a constant length, while those in a specific gravity scale grow smaller as the density increases. There is, accordingly, no simple relation between the two. The United States Bureau of Standards has determined that the readings on the Baumé scale may be converted to specific gravities by the following formulæ, in each of which B is the reading on the Baumé scale:

(1) For liquids heavier than water, specific gravity $= 145 \div (145 - B)$.

(2) For liquids lighter than water, specific gravity $= 140 \div (130 + B)$.

It should be noted that, in comparing the densities of liquids, it is customary to indicate the temperatures in each case; thus specific gravity at 60°/60° F. indicates that the specific gravity of the liquid at 60 degrees F. is referred to water at 60 degrees F. as unity. The formulæ given above are for specific gravities at 60°/60° F.

The hydrometer is an instrument used for determining the densities of liquids, such as water and oil. It consists of a stem near one end of which are fixed two bulbs. The upper bulb is the larger and is filled with air to provide buoyancy. The lower bulb is weighted to maintain the instrument in an upright position. When placed in a liquid the hydrometer sinks until the weight of the liquid displaced is equal to the weight of the hydrometer. Therefore, the denser the liquid the higher the stem is above the surface of the liquid, and vice versa. In order to utilize this feature for obtaining quantitative results, the stem of the hydrometer is graduated in accordance with some standard such as the Baumé.

Sterling, in the Marine Engineer's Hand Book, page 262, states in substance that the Baumé hydrometer has been generally adopted for the determination of the density of oils lighter than water. For heavy, viscous oils the use of the hydrometer is slow and liable to considerable error. Such oils may be heated to permit the use of the hydrometer, due correction being made for the change in temperature.

The second part of your question relates to the reading of a salinometer. The salinometer is a form of hydrometer commonly used for determining the presence and amount of sea or salt water in a marine boiler. The Marine Engineer's Hand Book, page 381, gives the following:

"The salinometer scale had its origin in the assumption that sea water contains 1 pound of salt dissolved in 32 pounds of water; thus, sea water is supposed to be 1/32 salinity. This is not strictly correct, as sea water varies somewhat in saline content. However, the salinometer scale indicates that according to the number of thirty-seconds on the scale there is a corresponding amount of salt in pounds for each 32 pounds of water."

In accordance with the foregoing, the salinometer readings are in thirty-seconds and are stated as one thirty-second, one and one-half thirty-seconds, etc.

The density of water is affected by its temperature, and this must also be taken when the salinometer readings are made, the salinometer being standardized for a certain water temperature.

Number of Oil Burning Vessels

Q. (1117).—Is any information available as to the number of ships now being fitted for burning fuel oil and also as to the probable results on the supply of fuel oil? What are the relative prices of fuel oil on the Atlantic coast, the Gulf and the Pacific coast?

A. (1117).—The "Register of United States Shipping Board Vessels" for 1920 shows 1,476 vessels; of these, 841 are coal burners and 635 oil burners, but of the coal burners 115 are under 3,000 tons deadweight (tugs, etc.). You probably know of the recent acute fuel oil shortage at the Atlantic coast ports. Current fuel oil prices are subject to fluctuation. The United States Shipping Board was able to contract last year with various companies as follows: The prices for oil at the Canal Zone were only slightly higher than those at the North Atlantic ports, the latter being perhaps 20 percent higher than the price at the Gulf ports near the fuel oil fields. The most recent quotations obtainable show that at Atlantic ports and in the Canal Zone the prices are practically the same, being about 40 percent higher than at Pacific ports. The price at the Gulf ports is between that on the Pacific and that at Atlantic and Canal Zone ports. In order to conserve fuel oil for the use of the merchant marine where it shows such great savings in greater deadweight capacity and smaller personnel it would seem as though all countries should discourage stationary plants from using it.

LAUNCH OF FRUIT STEAMER.—The Newburgh Shipyards, Inc., Newburgh, N. Y., recently launched the *Choluteca*, one of three similar vessels under contract by them for the Cuyamel Fruit Company of New Orleans. This vessel is of interesting type, inasmuch as it is especially constructed for the carriage of fruit (principally bananas), and passengers from Central American countries. The *Choluteca*, which is designed to carry a deadweight of 2,100 tons on a draft of 17 feet, and to have cargo hold capacity of about 140,000 cubic feet, has been built under the supervision of William Gardner & Company, naval architects, of New York, and will fly the flag of Nicaragua, the port of registry being Puerto Cortez. Accommodations have been arranged for a maximum of thirty-two first-class passengers in twelve staterooms.

PERSONAL MENTION

Louis A. Delaney, formerly mechanical engineer with F. X. Hooper Company, Glenarm, Md., is now manager of the American Sheet Metal Corporation, of Philadelphia, Pa.

Harry de Lapotterie has resigned his position with the Townsend Company, of New Brighton, Pa., to become industrial engineer of the Falls River Company, of Kent, Ohio.

L. E. Geary, former naval architect for the United States Shipping Board on the Pacific coast, has established himself in business at Seattle as a naval architect, engineer and broker.

D. T. Warden, formerly manager of the marine department of the Standard Oil Company of New Jersey, has become manager of the tank steamer department of the Tidewater Oil Company.

Harris McDougal, of the McDougal-Duluth Shipbuilding Company, Duluth, Minn., is in Europe in connection with a proposition to open up a ship repair plant in or near the port of New York.

W. F. Gibbs, chief of the construction department of the International Mercantile Marine Company, New York City, has returned to New York after a European trip in company with President P. A. S. Franklin.

C. C. Moss, hull surveyor for the Munson Steamship Line, New York City, has been appointed resident hull inspector on the new passenger ship being built by the New York Shipbuilding Corporation for the Munson Line.

Frank E. Kirby, retired naval architect from the Great Lakes, who was consulting engineer for the Submarine Boat Corporation, Newark Bay, N. J., during the war, has recently returned from an extended pleasure trip through China and Japan.

Captain L. H. Ellison, formerly with the United States Shipping Board and the Federal Shipbuilding Company, Kearny, N. J., has been appointed electrical engineer of the United States Mail Steamship Company, Inc., New York City. Captain Ellison graduated from the Virginia Military Institute in 1909, and from then until 1916 was connected with the United States Navy Yard at Norfolk, Va., in the electrical department. From January, 1916, to May, 1917, he was with the Western Electric Company at the Chicago plant as engineer in the manufacturing methods department, investigating methods and machinery developments. During the war, Captain Ellison served in this country and in France with the 37th Engineers and as engineer officer with the army transport service. After release from service in 1919 until his present connection with the United States Mail Steamship Company, Captain Ellison was with the Shipping Board in New York and the Federal Shipbuilding Company. He is a member of the American Institute of Electrical Engineers and of the American Association of Engineers.

Capt. L. H. Ellison

A. Pohlman, well known in the combustion field, is now with the engineering department of the Diamond Power Specialty Company, Detroit, Mich.

Robert L. Hogan, formerly chief hull draftsman for the Foundation Company at New Orleans, has resigned with the closing down of the yard and is now connected with the Newport News Shipbuilding and Dry Dock Company, Newport News, Va.

A. E. Saunders has recently joined George G. Sharp as partner in the latter's practice as consulting naval architects, engineers and marine surveyors at 30 Church street, New York City. Mr. Saunders has been engaged in shipbuilding in all its branches over a considerable period, and after receiving his training and technical education in Great Britain entered the service of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., as draftsman in the general drawing office and afterwards in the scientific department. On leaving Newport News he joined the scientific staff of the New York Shipbuilding Company, Camden, N. J., as estimating and designing draftsman and afterwards as assistant naval architect over a period covering eight years. On the formation of the Sun Shipbuilding Company, Chester, Pa., Mr. Saunders accepted the position of naval architect with that company, assuming full responsibility for the design of the tankers and freight steamers under construction at the yard. These vessels have given satisfactory service through a number of years of service and formed the basis on which standard vessels of this company were designed. Mr. Saunders later joined the technical staff of the American Bureau of Shipping as assistant to the chief surveyor covering the Philadelphia and Baltimore districts, and in that position had opportunity to become conversant with the inner workings of a classification society; ultimately, Mr. Saunders entered the construction department of the International Mercantile Marine Company as naval architect, from which position he resigned to engage in his present association with Mr. Sharp. Mr. Saunders is a member of the Society of Naval Architects and Marine Engineers and is also a member of the Institution of Naval Architects.

A. E. Saunders

John J. Muir, who until recently was connected with the United States Shipping Board Emergency Fleet Corporation, has opened offices at 2012 L. C. Smith building, Seattle, Wash., to engage in practice as a consulting engineer in marine and general engineering work. Mr. Muir has had considerable and varied experience in both lines of work in this as well as in foreign countries, including Calcutta, East India, having been engaged in the design and construction of marine engines for all kinds of service, and also the construction and operation of light draft steamers, barges and oil carrying steamers. His experience in general engineering work included the design and construction of Corliss and piston valve engines and rope transmission machinery for various kinds of heavy duty service, as well as ordinary service. Mr. Muir is a member of the American Society of Mechanical Engineers and the Engineers' Society of Western Pennsylvania.

C. W. WEAVER, who has acted as superintendent of hull construction at the Harlan plant of the Bethlehem Shipbuilding Corporation, Ltd., for the past four years, assumed the duties of general superintendent on December 1. This promotion was occasioned through the elevation of superintendent of machinery R. S. Campbell to the same post at the Sparrow's Point, Maryland, yard of the Bethlehem Shipbuilding Corporation, Ltd.

R. S. CAMPBELL, formerly superintendent of machinery at the Harlan plant of the Bethlehem Shipbuilding Corporation, Ltd., assumed on December 1 the same duties at the Sparrow's Point yard of the Corporation at Sparrow's Point, Maryland. Mr. Campbell has been directing head of the machinery department at the Harlan plant since January 1, 1917. The Maryland yard has a building capacity just double that of the Delaware yard.

SHIP REPAIR FACILITIES IN THE UNITED STATES

(*Continued from page* 81.)

REPAIR PLANT AND LOCATION.	MARINE RAILWAYS. CAPACITY IN TONS.	FLOATING DRY DOCKS. CAPACITY IN TONS.	GRAVING DOCKS. DIMENSIONS.	SHOPS.	SPECIALIZE IN REPAIRS TO
Southern Shipyard Corp., Newport News	3,000				General repairs.
Warwick Machine Company, Newport News					General repairs.
Washington					
Ballard Marine Railway Company, Inc., Seattle	600 400				General repairs.
Robert Campbell & Bros., Seattle	80′ x 30′				General repairs.
J. F. Duthie & Company, Seattle				Laying Out Shop, Mold Loft, Blacksmith Shop, Boiler Shop, Copper Shop, Machine Shop, Joiner Shop, Forge Shop, Plate Shop, Furnace Shop, Anglesmith Shop, Sheet Metal Shop, Carpenter and Pipe Shop.	General repairs.
Elliott Bay Shipbuilding Company, Seattle	600				General repairs.
Fishing Vessel Owners Marine Ways, Inc., Seattle	300 200				Wood vessels.
J. C. Johnson, Port Blakely	200				Wood vessels.
H. R. James Company, Seattle	1,300				General repairs.
D. W. Hartzell, Inc., Eagle Harbor	500				General repairs.
King & Winge Shipbuilding Company, Seattle					General repairs.
McAteer Shipbuilding Company, Seattle	1,000				Wood ships.
Marine Iron Works, Seattle	4 Marine Railways				General repairs.
Maritime Boat & Engine Works, Seattle	500				Tugs and barges.
Norway-Pacific Construction & Dry Dock Company, Everett		20,000			Steel ships.
Price Construction Company, Houghton	2,000				Wood ships.
Todd Dry Dock & Construction Company, (Todd Shipyards Corp.), Tacoma				Foundry, Pattern Shop, Anglesmith Shop, Mold Loft, Machine Shop, Blacksmith Shop, Boiler Shop, Joiner Shop, Paint Shop, Copper Shop, Pipe Shop, Rigging Loft and Carpenter Shop.	Steel vessels.
Todd Dry Dock, Inc. (Todd Shipyards Corp.), Seattle		4,000	Two docks of 12,000 tons capacity each.	Completely Equipped Plant.	General repairs.
West Virginia					
Kanawha Dock Company, Point Pleasant		Sectional Dock 50′x200′			River craft.
Point Pleasant Dry Dock Company, Point Pleasant			212′ x 56′ x 11′ water O. S.		River craft.
H. A. Wintus, Parkersburg		4 Section Dock			River craft.
Wisconsin					
American Shipbuilding Company, Milwaukee			311′ x 45′ x 12½′ water O. S. 445′ x 61′ x 14½′ water O. S.		General repairs.
American Shipbuilding Company, Superior			609′ x 66′ x 15½′ water O. S. 620′ x 66′ x 20′ water O. S.	Paint Shop, Woodworking Shop, Rigging Loft, Plate Shop, Blacksmith Shop, Machine Shop, Carpenter and Joiner Shop.	General repairs.
Leathem & Smith Towing & Wrecking Company, Sturgeon Bay			248′ x 41′ x 14′ water O. S.	Blacksmith Shop, Machine Shop.	Tugs and barges.
Manitowoc Shipbuilding Corp., Manitowoc		360′ x 70′	340′ x 44′ x 12½′ water O. S.	Machine Shop, Electrical Shop, Tin Shop, Joiner Shop, Planing Mill, Mold Loft, Pipe and Coppersmith Shop, Pipe Bending Shop, Pipe Shop, Paint Shop, Blacksmith Shop, Plate Shop, and Angle Shop.	Steel ships.
Racine Boat Company, Racine	100′ long				Yachts.
Ryan & Son, Oshkosh	300 300				River craft.
Sturgeon Bay Dry Dock Company, Sturgeon Bay		1,200			General repairs.

Shipbuilding and General Marine News

Contracts for New Ships — Shipyard Improvements — Engineering Projects—Improved Appliances—Personal Items

MILLIONS WORTH OF SHIPS UNDER DESIGN AND SUPERVISION OF TWO NEW YORK NAVAL ARCHITECTS

Several Types of Vessels, Including Tankers, Freighters and Passenger Ships to be Constructed in 1921

Although some are pessimistic regarding the immediate prospects for shipbuilding, it was learned by MARINE ENGINEERING that one prominent naval architect alone has $45,000,000 worth of work on his boards and under his supervision, while another similar firm has under its design and supervision several new vessels and the conversion of two others.

Theodore E. Ferris, naval architect and marine engineer, of 30 Church street, when interviewed, had his coat off and sleeves rolled up, as in the days when shipbuilding was at its peak. Mr. Ferris stated that he has under his design and supervision 14 oil tankers for the Atlantic Gulf & West Indies Steamship Company and their subsidiaries; a combination cargo and passenger vessel for the Munson Steamship Line; two passenger ships for the Red "D" Steamship Line, the contracts for which are about to be placed; and several other designs of proposed oil tankers and passenger vessels, concerning which he does not feel at liberty, at this time, to give out details. Mr. Ferris is also in charge of the reconditioning of the *Brazos,* of the New York & Porto Rico Steamship Company, and the *San Jacinto,* of the Mallory Steamship Company.

Messrs. George G. Sharp and A. E. Saunders, naval architects, of 30 Church street, have the following work under their design and supervision:

One single-screw molasses steamer under construction at the Curtis Bay Copper & Iron Works, Baltimore. This vessel is of the three-island type, and has a deadweight capacity of 2,600 tons. She is fitted with triple expansion engines and has a designed speed of 12 knots.

One bulk oil barge for the Terry Shipbuilding Company, Savannah, Ga.; a two-masted, seagoing tow barge, having a deadweight capacity of 3,600 tons.

One salvage steamer for South American owners, the contract for which is not placed. This is a twin-screw vessel having a designed speed of 14 knots. She is to be equipped with wrecking and large pumping machinery.

Seven Hog Island Type A steamships to be converted to bulk oil steamers. Five of these vessels are for the American Fuel Oil & Transportation Company, and two for Charbonneau, Rajolo & Company. These vessels have a deadweight capacity of 7,500 tons.

Several five-masted schooners to be converted from standard Shipping Board wood steamers for Italian owners. These vessels are intended for the coal trade and have a capacity of 4,000 deadweight tons.

NEW YORK SHIPBUILDING CORPORATION ACTIVITIES

Construction activities continue brisk at the yard of the New York Shipbuilding Corporation, Camden, N. J. According to the latest announcement from that corporation, work is being conducted on a total of thirty ships. Due to the capacity of the yard, however, which has over 19,000 men on the payroll, the corporation is in a position to accept additional contracts and to offer as favorable delivery dates as any other yard in this country or abroad. The list of work on hand at the plant at the present time is as follows:

Of the sixteen combination passenger and cargo vessels ordered by the United States Shipping Board, three of them are delivered and the rest will follow at short intervals.

Four 12,600 deadweight ton tankers for the Standard Transportation Company, of New York (Standard Oil Company's marine department).

One 9,820-ton tanker for the United Fruit Company. The ship has been launched and is scheduled for early delivery. One duplicate of this boat for the Pacific Mail Steamship Company, which, it is expected, will be delivered late in the spring.

Two more of the same type which are being built as stock boats for sale. These are expected to be completed in the late summer and early fall respectively.

One passenger liner for the Munson Steamship Company which should be ready for launching about the middle of 1921.

The yard has completed an order for thirty destroyers, five of which remain to be delivered early in 1921. The corporation also has under construction for the navy, two large electrically driven battleships and one battle cruiser.

W. L. PEEBLES NAMED AS NEW YORK MANAGER

Announcement is made of the appointment of W. L. Peebles as New York manager for the Marine Decking & Supply Company, with offices at 3708 Woolworth building, New York City. Mr. Peebles was formerly associated with the Pennsylvania Railroad at New York and Baltimore, and the Philadelphia & Reading Railroad, at Philadelphia.

The Marine Decking & Supply Company deals extensively in litisilo, tackle blocks, paints, boiler cleaning and scaling, etc. It is a manufacturing company, with factories in Philadelphia and Easton, Pa. It is claimed that approximately 80 percent of the decking on the larger ships of the United States is of litisilo, which material is fire, water and vermin proof.

FIRST OF TEN SCOUT CRUISERS LAUNCHED

The *Omaha,* scout cruiser number 4, the first of ten such vessels authorized by Congress in its 1916 building program and said to be the first vessel of this type to be built for the Navy in thirteen years, was launched at the Tacoma, Wash., plant of the Todd Shipyards Corporation on December 14. Its predecessors were the *Chester, Birmingham* and *Salem,* launched in 1907. The *Omaha* is of 7,500 tons displacement 550 feet 6 inches over all length, 55 feet 4 inches beam, with a mean low draft of 13 feet 6 inches. She is equipped with four engines developing 95,000 indicated horsepower and will maintain a speed of 35 knots.

The *Omaha* was sent into the water bow first instead of stern first.

DR. W. L. R. EMMET AWARDED GOLD MEDAL

The Franklin Institute of the State of Pennsylvania, acting through its committee on science and the arts, at its meeting on November 17, 1920, awarded to Dr. W. L. R. Emmet, consulting engineer of the General Electric Company, Schenectady, N. Y., its Elliott Cresson Gold Medal. The wording of the award is as follows:

"After a careful consideration and study of Dr. Emmet's work relating to ship propulsion, the institute is of the opinion that it deserves the highest award in its gift for the recognition of inventions of signal importance and awards to Dr. W. L. R. Emmet the Elliott Cresson Medal in recognition of his notable contribution to The Art of Ship Propulsion."

BUSINESS NOTES

The Metal & Thermit Corporation, New York, in order to take care of its rapidly increasing business in the New England territory, has opened a branch office at 141 Milk Street, Boston. Inquiries addressed there will have the personal attention of the New England District Manager, Robert L. Browne. Orders, however, should continue to be addressed to the General Office of this company at 120 Broadway, New York.

The Oxweld Acetylene Company announces the appointment of the Standard Supply & Equipment Company, of New York and Philadelphia, as eastern sales agent for eveready welding and cutting apparatus and supplies.

The Standard Supply & Equipment Company deals in shelf and heavy hardware, machinery, mill and mine supplies, automobile accessories, etc., and has, besides its New York and Philadelphia establishments, branch houses in New Haven, Hartford, Springfield, Worcester, Pittsburgh, Trenton and Altoona. The company has appointed as manager of its welding and cutting equipment department, Mr. George E. Temple, for six years connected with the Prest-O-Lite Company, which formerly manufactured and marketed the apparatus now everywhere known as "Eveready."

The George A. Fuller Company has completed its contract with the United States Shipping Board Emergency Fleet Corporation with the delivery of the steamship *Syros* by the Carolina shipyard of that company. The *Syros* was the eighth 9,600 deadweight ton cargo steamship delivered to the Fleet Corporation by this contractor within a period of ten months. The Carolina yard is now engaged solely in the construction of oil tankers, the first of which will be delivered to British owners during January.

Frank Thornton, Jr., chief engineer of the Westinghouse Electric Products Company, has been appointed manager of the electric heating department of the Westinghouse Electric & Manufacturing Company. Mr. Thornton was graduated from the University of Missouri in 1908, spent a year studying in Europe and joined the Westinghouse Company in May, 1909.

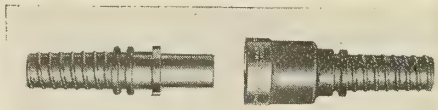
Announcement is made of the change of name of the Lewis & Roth Corporation to the Electric Power Equipment Corporation, Philadelphia. This change affects the name only, the personnel, sales policy and manufacturing product remaining the same.

The consolidation of the Whiting Foundry Equipment Company of Harvey, Ill. and the American Foundry Equipment Company of New York City, recently announced, has not been consummated and the two companies will continue as separate concerns the same as heretofore.

O. E. Falls, who has had many years of experience in charge of foundry and thermit welding work at the Norfolk Navy Yard, Portsmouth, Va., has accepted a position with the Metal & Thermit Corporation, New York. Mr. Falls obtained his earlier foundry experience from positions held at the Norfolk & Western Railway Shops, Roanoke, Va.; the Richmond Locomotive Works, Richmond, Va., Pennsylvania Engineering Works, New Castle, Pa.; the Franklin Air Compressor Works, Franklin, Pa.; the Seaboard Air Line Railway Company's Shops, Portsmouth, Va.

"Little David" Couplings

A hose coupling with several new features has recently been placed on the market by the Ingersoll Rand Company, New York. This device is called the "Little David" hose coupling and will be distributed as an accessory to the line of pneumatic tools manufactured by the same company.



Pneumatic Hose Coupling

The design of the "Little David" coupling has been with the view to overcoming these troubles. The coupling consists of two parts, male and female. The female end is fitted with a V-shaped rubber gasket providing an air tight joint. The gasket is prevented from blowing out should the coupling accidentally be disconnected under pressure, by a protective shoulder inside the coupling. The female end is exceptionally sturdy, there being no exposed parts which might be liable to injury and cause jamming or sticking. The locking shoulders are heavy with large bearing surface. The locking spring can be replaced if necessary.

"Little David" hose couplings are manufactured in ½-inch and ¾-inch sizes, which are interchangeable; that is, a ½-inch male piece may be used with a ¾-inch female end or vice versa. Gaskets are also interchangeable between the different sizes.

New Immigration Service

With the sailing on Christmas Day of the steamship *Mount Clay* of the United American Lines, from New York to Hamburg, a service will be inaugurated which marks a new era in immigrant ocean travel.

The *Mount Clay*, which was formerly the *Prinz Eitel Friedrich*, is a twin-screw steamer of 10,000 tons, capable of making 15 knots. It has been entirely refitted for third-class passenger accommodation, and affords convenience and comfort that were unknown to third-class or steerage passengers in the days before the war.

It is the intention to add five other steamships to this third-class passenger service between Hamburg and New York, so that by the beginning of summer there will be regular weekly sailings.

New Oil Tanker

The oil tanker, *District of Columbia*, left the ways at the south plant of the Baltimore Dry Dock & Shipbuilding Company, at noon, Saturday, December 18, 1920.

She is of 10,300 deadweight tons, 430 feet in length, 59-foot beam; 33 feet, 3 inches in depth, will have 2,650 shaft horsepower; single screw; geared turbines; with a speed of 10 knots; equipped with three Scotch boilers, oil burning; forced draft; having a cargo capacity of 3,000,000 gallons.

Navy Program Moving

The United States Navy's shipbuilding program is being carried steadily forward, according to the annual report of the Secretary of the Navy for the fiscal year ended June 30, 1920, and issued December 13, 1920. In connection with the three-year construction program of 1916, the report says in part:

"Construction of the 16 capital ships authorized in the three year program of 1916 is now going forward. Suspension of work on them during hostilities enabled our construction engineers and naval experts to take advantage of war experiences of other countries as well as our own to make a thorough study of latest developments so as to embody the most modern improvements in its structure and armament. These battleships of 43,200 tons and battle cruisers of 43,500 tons will be larger and more powerful than any heretofore built and without equal in speed and gun power."

In a statement issued by the department it is set forth that "the electrical operation of the navy's new line of six battle cruisers now building under the 1916 naval program will represent, according to Rear Admiral R. S. Griffin, chief of the Bureau of Engineering, the greatest horsepower per shaft that has ever been projected in any marine installation, irrespective of type of motive power."

According to the naval report of Rear Admiral David W. Taylor, chief of the Bureau of Construction and Repair, nearly 200 warships, including one superdreadnaught and 96 destroyers, were completed in the United States in the fiscal year ended last June 30, and more than 100 others, including 11 superdreadnaughts, were building at that time. Admiral Taylor estimated that $119,000,000 would be required in the fiscal year beginning next June 30 for continuing work on the ships building.

Noteworthy Performance

The splendid performance of the steamship Kandahae, owned by Ellerman & Bucknell, has recently attracted considerable attention. This vessel is of 10,750 deadweight tonnage, equipped with triple expansion engines, with cylinders 25½ inches, 43½ inches and 76 inches diameter by 51 inches stroke, developing 3,200 indicated horsepower at a speed of 12 knots. It is fitted with three single end Scotch boilers with Howden forced draft, and with fire tube superheaters delivering 200 degrees at the main engine throttle. She burns about 42½ tons of coal per 24 hours or about 1.24 pounds of coal per indicated horsepower for all purposes. This vessel has been operating since 1913.

Shipmasters Join Neptune Association

By a vote that was virtually unanimous, the Shipmasters' Association of the United States, with headquarters at Seattle, Wash., has decided to disincorporate and join the powerful Neptune Association, with headquarters in New York.

AMERICAN SHIPS CARRY BIG VOLUME OF FOREIGN TRADE

Merchant Fleet Increased by 670 Vessels—Additional Funds Asked for Overseas Commerce

A new high record for foreign trade was established by American ships according to the annual report of Secretary Alexander, of the Department of Commerce, which states that they carried nearly one-half of the nation's overseas commerce during the past fiscal year. The figures indicated that the overseas trade reached the unprecedented total of $11,875,424,000 and $5,071,905,000 of this amount was carried in American owned vessels as against $368,359,000 carried in American ships the year before the war.

The American merchant fleet during the last fiscal year was increased by 670 vessels of 3,516,000 gross tons, Mr. Alexander also shows, and on June 30, American shipping comprised 28,183 vessels of 16,324,024 gross tons as compared with 7,928,688 tons in 1914. Growth of American shipping, the report says, has been wholly in the foreign trade, much more than half of that growth having taken place since the armistice of November 11, 1918.

In connection with the growth of American shipping in foreign trade, Mr. Alexander discussed the advisability of charging off "to the winning of the war" sufficient of the war cost of the Government owned ships to enable them to compete with foreign shipping on the basis of actual value of the properties. The secretary expressed the belief that American exporters would find it "increasingly difficult" to maintain their vessels in foreign markets without adequate Government aid, and he urged Congress to provide for the expansion of the foreign attache service and asked for increased appropriations to be used in the promotion of foreign trade. For Latin-American trade development Mr. Alexander recommended expenditures of 50 percent more than was used in this field last year.

Estimates of appropriations required for the department of commerce for the fiscal year of 1922 were placed by the secretary at $30,383,481, an increase of $10,121,712 over those of the past year.

Launching Records Broken

The world's pre-war record of launchings during the last fiscal year was broken by American shipbuilders, according to figures given in the annual report of the Commission of Navigation, at Washington. American ships built and documented during the year aggregated 3,880,639 gross tons, the report stated, adding that British ships under construction on June 30, 1920, aggregated 3,808,056 tons. American shipyards reached a rate of 4,258,141 gross tons a year at the end of December, 1919, the report shows, and at the end of March, 1920, they had built steel ships alone at the rate of 3,679,185 tons a year, a small portion of these being foreign tonnage.

Up to July 1, last, American tonnage sufficient to carry 60 percent of the foreign trade of the United States had been registered. During the year, American ships actually carried 45 percent in value of the exports from the United States, and 39 percent of the imports, the report sets forth. American ships in 1914 carried but 10 percent of this country's exports and imports.

Navigation Bureau Report

The Bureau of Navigation, Department of Commerce, Washington, D. C., reports 118 sailing, steam, gas and unrigged vessels of 213,957 gross tons built in the United States and officially numbered during the month of November, 1920. Of this number, twenty-six were steel steamers totaling 134,649 tons. From other sources than construction, two vessels of 17,889 gross tons were admitted to American registry.

American Design Will Be Used for Italian Ships

A. C. Rimmer, consulting engineer and naval architect, 149 Broadway, New York, is completing the shipment to Italy of a large amount of fabricated steel that was left in this country due to cancellations of contracts for 9,000-ton steel steamers by the United States Shipping Board.

A large part of the material is completely fabricated and ready for erection other parts of the hull are only partly fabricated while other material is only in the plain state as received to shipbuilder's specifications from the steel mills. The fabricated and semi-fabricated material has been gathered together from the many structural plants throughout the country who were fabricating this type of ship and has been sorted, inspected and shipped in such a manner that the sections can be used in Italy for ships of American design and on the American fabricated principle with very little waste. The units were shipped in such a manner that construction could be started as soon as the first material arrived abroad so that we shall soon see coming to our shores under a foreign flag vessels designed and partly built in this country.

The vessels as built in this country were equipped with watertube boilers and geared turbines, but it is the intention of the Italian shipbuilders to install oil burning Scotch type boilers and reciprocating engines.

Mr. Rimmer has also handled the shipping of a large amount of shipyard and shipbuilding equipment and stock for the construction of vessels of Italian design.

Two More Ships Launched

Recent launchings by the New York Shipbuilding Corporation include two ships, the *Lone Star State* and the *Centennial State*. The *Lone Star State* is one of sixteen passenger and cargo ships for which the company was given orders during the war by the Emergency Fleet Corporation. These boats were originally intended for transports, but with the signing of the armistice they were held up and eventually changed to passenger and cargo liners. Three have been delivered, the balance were launched with the exception of two, which will be launched the early part of 1921, and all are well under way. The *Lone Star State* is 21,000 displacement tons, the *Centennial State* of 13,000 deadweight tons.

Arrange Winter Lectures for Ocean Engineers

The Educational Department of Ocean Marine Engineers' Beneficial Association, Number 80, 15 Whitehall Street, New York City, has arranged for a series of lectures on modern marine propelling and auxiliary equipment, these lectures to be given every Tuesday evening during the winter.

On December 21, the lecturer, H. B. Taylor, chief engineer of the turbine department, Division of Construction and Repair, United States Shipping Board, spoke on the development of the marine turbine up to the present day geared type. This lecture was well attended by superintendent engineers and operating marine engineers, and Mr. Taylor was given an enthusiastic reception, his talk being looked upon as a long step forward in the educational work conducted by the organization.

On Tuesday, December 14, P. J. Henning gave a very instructive lecture on "Turbo Electric Drive" explaining in detail the operation of the ship *Eclipse*.

Shipping Board Approvals

The Shipping Board has approved applications for the construction in accordance with the provisions of Section 23, of the Merchant Marine Act, 1920, submitted by the following companies of the vessels indicated in order that they may obtain the benefits of the provisions of the said section:

Alaska Steamship Company, 120 Broadway, New York City, 6,000-ton twin-screw cargo motorship, Todd Drydock & Construction Company, Tacoma, Wash.; Calvert Navigation Company, Baltimore, Md., steel tanker, 10,200 tons deadweight, Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md.; Sinclair Navigation Company, 120 Broadway, New York City, two bulk oil tankers of 6,900 deadweight tons each, Bethlehem Shipbuilding Corporation, Harlan Plant, Wilmington, Del.

Section 28 Further Suspended

At a general session of the Interstate Commerce Commission held at its office in Washington on December 11, it was ordered that the provision of Section 28 of the Merchant Marine Act of 1920 be further suspended from and including the first day of January, 1921, until further order of the commission.

AMERICAN STEAMSHIP LINES PLAN CONSTRUCTION OF NEW VESSELS

Shipbuilding is believed by many to have taken a decided turn for the better. One of the chief influences to this end is seen in the announcement that more than fifteen United States steamship lines have filed notices with the Treasury Department that they intend to take advantage of Section 23 of the Merchant Marine Act of 1920, whereby excess profits earned by American ships engaged in foreign trade are exempt from taxation, provided they are to be reinvested in the construction of new ships.

It is stated that the American Line had deposited a large sum of money with a New York trust company, and had notified the Internal Revenue Bureau and the Shipping Board that it proposed to invest the amount exempted from taxation in new construction of American-flag vessels. The controller of the American-Hawaiian Steamship Company stated that he had followed similar procedure. The Kerr Steamship Company, through its attorneys, has made application to the Shipping Board to be permitted to reinvest the money which it realized from the sale of the seven ex-Austrian steamers to the Harriman interests, while other companies are reported to have taken similar action. The Munson Steamship Line, it is reported, will ask that the exempton from excess profits taxes of its ships engaged in foreign trade be made applicable to the 6,000-ton passenger liner which it is building at the Camden plant of the New York Shipbuilding Corporation.

Contracts for two motorships to be built by the Merchant Shipbuilding Corporation have been awarded by the American-Hawaiian Steamship Company. The American Line has drawn up plans for two passenger liners, although the contract has not yet been awarded. The Red "D" Line, the Pacific Steamship Company, and the New York & Porto Rico Steamship Company are also reported to have plans prepared for passenger liners.

26 SHIPS UNDELIVERED

Shipping Board Has Many Vessels at Delaware Yards

Announcement in Washington that the United States Shipping Board had applied to Congress for a deficiency appropriation of $95,000,000 to complete ships now under construction, gave rise to unfounded rumors that changes might be made in the Government's shipbuilding programme, which would result in the cancellation of some vessels now under construction in Delaware River shipyards. These rumors were promptly denied by local officials of the Emergency Fleet Corporation, who pointed out that even if cancellations were being considered, they could not be made because of the advanced nature of the work on ships being built for Government account.

The Atlantic Coast Shipbuilders' Association's Philadelphia office learned from an official of the Emergency Fleet Corporation, that there remain under construction on the Delaware River for the United States Shipping Board twenty-six vessels being built at five different shipyards, all of which are expected to complete their schedules by March 1, except the New York Shipbuilding Corporation, which has several combination passenger and freight ships that will not all be delivered before September 1, 1921.

The Chester yard of the Merchant Shipbuilding Corporation, the Sun Shipbuilding Company, and the Gloucester and Wilmington plants of the Pusey & Jones Company, have delivered all vessels for Government account.

HARLAN PLANT PRODUCTION

With the delivery of a cargo ship and a tanker in December, the Harlan plant of the Bethlehem Shipbuilding Corporation, Ltd., at Wilmington, Del., rounded out a production year of 67,500 tons for a five-way yard.

The late 1920 deliveries included the last Emergency Fleet contract, the *Natirir*, a 7,400-ton cargo carrier, and the *Eugene V. R. Thayer*, a 12,600-ton tanker for the Sinclair Navigation Company. December also saw the launch of another 12,600-tonner for the Sinclair Navigation Company, the *Albert E. Watts*, making nine ships accepted and ten launched.

COMPLETES GOVERNMENT SHIPBUILDING PROGRAMME

The Newburgh Shipyards, Inc., Newburgh, N. Y., completed its shipbuilding programme for the Government with the delivery on Tuesday, December 21, of the *Storm King*, and commemorated its building programme for ships of private ownership with the delivery on Thursday, December 23, of the *Herman Frasch*.

The *Storm King* is a steel vessel of 8,434 tons dead, and the *Herman Frasch* is a twin-screw vessel of 7,304 tons.

BOARD POSTPONES SALE

The Shipping Board has decided to postpone for the present the sale of surplus material on the Pacific Coast now being advertised.

FAVORS AMERICAN SEAMEN

Chairman Benson Urges American Men for American Ships

The following letter has been released to all operators of Shipping Board ships:

"The conditions which now prevail in the ocean carrying trade have forced the United States Shipping Board as well as private shipowners to lay up a great many vessels, which automatically sets adrift a large number of seafaring men.

"As the representative of the largest shipowning corporation in the world, the chairman of the Shipping Board feels that it is timely to invite the attention of owners and operators to the fact that the largest factors in vessel expense under the conditions which prevail at this time are repairs and fuel.

"While the policy of every prudent owner and operator is rightfully toward reduction in vessel expense, the chairman of the Shipping Board earnestly cautions all shipowners and operators not to be misled at this time into the employment of foreigners merely because it may be possible to obtain them at a lower schedule of pay than is satisfactory to American seamen.

"The true goal of American effort is to increase the efficiency of operation. The most certain means to this end is improvement in the efficiency of sea labor. This improvement in turn has been brought about by getting the American man afloat and can best be continued by keeping him afloat.

"The chairman of the Shipping Board appeals in the strongest possible terms to every right-minded and patriotic American citizen who owns, operates or has any interest whatever in American shipping to seize this opportunity to collect American seamen in American ships rather than to drive him from the sea by yielding to the temptation of minor savings in the wage scale. (Signed) W. S. BENSON, Chairman."

TO RECONDITION STEAMERS

Plans of the United States Mail Steamship Company, New York, call for placing four ex-German passenger liners, the *Amerika, Pocahontas, Antigone* and the *Princess Matoika*, into service within the next two months, according to Capt. O. W. Koester, vice-president in charge of construction and repairs. Vigorous denial was made of a report that negotiations were in progress between the steamship company and German shipyards to have the reconditioning of the liners done in German yards. Contracts for the reconditioning of the *Amerika* and the *Antigone* will be awarded shortly. The plans and specifications for the conversion of the *George Washington* into an oil burner and her reconditioning have just been completed, while the delay in the award of contracts for the *George Washington, Mount Vernon* and the *Agamemnon* is due to the fact that the company expects to equip all of these fast liners to burn oil for fuel, Capt. Koester stated.

BRITISH SHIPBUILDING PASSING THROUGH TRADE DECLINE

The crisis in the British shipbuilding industry, which has been anticipated for some time, now appears to have arrived. Contracts are continuing to be cancelled and no new contracts are being received. Furthermore, work is being stopped on vessels under construction and keels of cargo steamers laid down are being scrapped. The reason for this is that it does not pay to build ships under present conditions. The high cost of new tonnage and the present poor freight rates charged make it impossible for new vessels to be operated profitably. Moreover, the English Ministry of Shipping, which has recently disposed of a large number of German surrendered vessels, has caused the construction of new ships to become less. These vessels, although not sufficiently numerous to increase the mercantile marine to its normal limits, constitute tonnage ready to hand and the costs of repairing these vessels is much lower than the cost of new ones.

Many attempts have been made to discover the reasons for the falling off in trade, but all these have come back to the one thing—the high cost of production. Sir Alfred Palmer, speaking on the industrial situation in Jarrow, stated that if all would only pull together the employers in bringing and keeping their works up-to-date and in considering the welfare and happiness of their workmen, and the employees working hard and honestly without absenteeism and going easy, and if all would strive to help the Empire to pull round after the war, then no doubt trade would improve in the future. He further stated that employees must understand that it is not a question of fighting the employers and capital, but rather of fighting foreign competition. Workmen have their demands for an increase of wages on the cost of living, but prices have commenced to fall and are expected to fall much more rapidly in the near future. If the workers would only have a little patience they will find an appreciable difference in the cost of living. The employers are also anxious to reduce the cost of living, and in resisting unreasonable wage demands are doing much towards this end.

While no settlement has been arrived at on the wage question, the workmen employed on engineering work and in engineering, boiler making and foundry departments are conceded a big concession by the employers at a conference held at York. A three-shift system was satisfactorily agreed upon, by which it is thought all the unemployed in the engineering industry will be absorbed. The first shift will consist of 43 hours, for which 47 hours will be paid; the second shift will be of 37½ hours, for which 47 hours will be paid, and the third shift will be of 37½ hours, for which 50 hours will be paid.

The shipyard joiners' strike and the strike of the Tyne and Tees tugboatmen still show no signs of settlement. Ships are being launched by the use of only one tug, and the docks are gaining experience in the handling of ships with the aid of steam launches.

Prices of shipbuilding materials have also weakened, principally due to the foreign competition. Large quantities of ship plates have been imported from the Continent and America at much lower prices than those quoted by English firms. Steel forgings are also being imported again from the Continent. These two facts alone are compelling British steel makers to reduce their scales of prices.

RESIGNS FROM LLOYD'S

Sir Thomas L. Devitt, chairman of Lloyd's *Register*, is resigning from that post. Sir Thomas first became a member of the committee in 1893, was elected chairman of the subcommittees of classification in December, 1897, and chairman of Lloyd's *Register* in 1909, which position he has held since. Sir Thomas is resigning, owing to failing health.

SHIPBUILDING IN JAPAN

An investigation made by the Japanese authorities shows that the number of steamers in the course of construction in Japan in October was 38, the total tonnage of which was 186,190. These include 19 stock boats of 89,520 tons, 14 of which are being built at the following shipyards:

SHIPYARDS	Number of Vessels	Tonnage
Asano Shipyard	2	10,800
Harima Shipyard	3	14,600
Osaka Iron Works	2	14,600
Aizawa Shipyard	2	5,700
Kawasaki Dockyard Company	3	17,800
Mitsui Bussan Dockyard Company	..	11,600

According to an investigation made by the Department of Communication, the total number of steamers of 20 tons and upwards was 3,090 in July, and the tonnage 3,141,729.

TO HOLD BUSINESS SESSION

The general meeting and business sessions of district managers and sales engineers will be held at the Pawling & Harnischfeger plant auditorium, Milwaukee, Wis., January 25 to 27. A general review of the past year's business will be discussed and plans for future sales in the various lines—cranes, hoists, excavating machinery and machine tools—will be outlined. Developments made in design and manufacture, also contemplated developments in connection with these lines, will be the subject of talk by the engineers and department heads. The meeting will be held under the direction of Mr. A. G. Hendricks, vice-president and general manager of the company.

PRESENT AND PRE-WAR COST OF BRITISH SHIPPING

Speaking at South Shields, Mr. Charles Rennoldson, of Chas. Rennoldson & Company, South Shields, stated that before the war a ship was built for about £27 (approximately $95 at the present rate of exchange) per ton, while the prices to-day range from £36 (approximately $126) to £37 (or $129.5) a ton.

STEAMER LAUNCHED

Messrs. William Gray & Company, Ltd., have launched at West Hartlepool, the steel screw steamer *Nirpura*, which they are building for the British Steam Navigation Company, Ltd., London. The vessel is 463 feet 6 inches overall length, with a breadth of 56 feet. The double bottom tanks are arranged for the carriage of oil cargoes and are fitted with steam-heating pipes to liquify thick oil. The cargo gear consists of fourteen derricks fitted on posts with fifteen steam winches, which exhaust into a winch condenser of the "CMEW" type.

The propelling machinery, built at the central marine engine works of the builders, consists of triple expansion engines with cylinders 28 feet 46 inches, 77 inches diameter by 54 inches stroke, and four boilers.

WORLD'S SHIPBUILDING

Drop of Only Five Percent Noted in Last Quarter

Shipbuilding throughout the world is only about 5 percent less than three months ago, although there has been a general contraction in construction, says a statement issued by Lloyd's Register of Shipping.

The total now building in the world is given as 7,179,000 gross tons, in comparison with 7,565,000 tons at the end of the third quarter of 1920. France and Holland are practically the only countries to show a gain in the amount of construction.

For the first time since the war period British shipbuilding shows a decline. The recession is only a small one, however, 3,709,000 gross tons being in hand at the end of December, compared with 3,731,000 tons at the end of last September. The decrease of 22,000 tons compares with one of 462,000 tons for American shipyards, the aggregate under way in this country at the end of 1920 being 1,310,000 tons, compared with 1,772,000 tons three months previously.

Other countries than the United States and the United Kingdom show an advance of 98,000 tons, but this is accounted for by the increase in the amount of building in France from 293,000 tons to 397,000 tons and in Holland's total of 450,000 tons compared with 424,000 tons in the previous quarter.

Fifty-one and six-tenths percent of the world's shipbuilding is now being done in Great Britain, compared with 38.1 percent at the beginning of 1920. In the same period the United States' share of the total has decreased from 37.7 percent to 18.2 percent. Today, therefore, the United Kingdom is building more than all the rest of the world combined, a position held by the United States during the period of the intensified shipbuilding campaign in this country.

BRITISH SHIPYARD IS WELL SUPPLIED WITH ORDERS

The keel for the first vessel to be built in the new yard of the Palmer Shipbuilding & Iron Company at Amble, England, on the Northumberland coast, has just been laid, and it is anticipated that the whole yard will be in full working condition early in the new year. This yard was laid down during the war for the building of concrete vessels, but the Palmer Company has now equipped the yard with all modern appliances for the building of smaller steel craft, which can be more advantageously built there than at their other yards at Jarrow or Hebburn. They have several orders in hand for such vessels, and the first ship laid down is a twin-screw ferry steamer.

The Palmer Company is well supplied with orders and can keep its Tyne yard going for a considerable time. The company has recently contracted for the conversion of the *Titan*, owned by the Cie Generale Transatlantique, from a cargo boat to an oil carrier. Two other large oil carriers are in dock undergoing extensive overhaul.

FOREIGN ACTIVITIES

New Ships and Repairs

The oil tanker, San Fernando, owned by the Eagle Transport Company, is undergoing repairs at the yards of Messrs. Swan Hunter & Wigham Richardson. This ship has a carrying capacity of 13,200 tons and is 539 feet long. The American ship, Siboney, which was damaged through going ashore at the Spanish coast, is also being repaired. She is of 7,653 tons and is 423 feet long.

The Middle Docks & Engineering Company has for repairs the steamer Sygna of 3,881 tons.

Sir W. G. Armstrong-Whitworth Company, Ltd. has in hand the building of a motor tank ship of about 6,500 tons, while Denny & Brothers, Dumbarton, Scotland, has just contracted to build a 10,000 ton motor tank ship for the British Tanker Company, Ltd.

Vickers, Ltd., of Barrow, has under construction four tankers for Tankers, Ltd.

Harland & Wolff, Ltd., one of the largest shipbuilding and repairing concerns in Great Britain is opening a ship repairing and engineering branch on the River Thames, London. This firm has concluded a contract with the Port of London Authority to take over its engineering repairs and construction work, and has agreed to construct buildings of a prominent character of not less than £300,000 (approximately $10,500,000 at the prevailing rate of exchange) in value as well as two slip ways for ship repairing and possibly shipbuilding. It is understood that the firm will devote the greater part of its attention to the overhauling and repairing of vessels trading with the port of London.

The sailing bark Portugal, owned by the Empreze Portuense de Transportes Maritimos, Ltd., is at present in the Clyde being converted into an auxiliary by Messrs. William Beardmore & Company, Ltd., Coatbridge. The vessel is of steel and has a deadweight carrying capacity of 2,000 tons. When completed, it is proposed that the ship will trade mostly between Portugal and the States.

Two new motor coasting vessels are now in course of construction at the yards of the London-Montrose Shipbuilding & Repair Company, Montrose, to the order of A. Besse, Esq., Aden.

Launchings

Steamer Eastney by the Northumberland Shipbuilding Company, Ltd., at Howdon-on-Tyne for the Ronney Steamship Company, Ltd. Length 375 feet, 8,000 tons deadweight.

Steamer Alu Mendia by the Ropner Shipbuilding & Repair Company, Ltd., Stockton-on-Tees, for Sota & Aznar, Bilbao, Spain; length 310 feet.

By the Northumberland Shipbuilding Company, Ltd., steamer Adamello of 9,250 tons deadweight and the steamer San Michele of 8,100 tons deadweight for Messrs. Comsorzio Veneziano di Armamemento e, Navigaziano, Venice, Italy.

Dutch minelayer, Van Meerlant, by the Werf Gusto, Firma A. F. Smulders of Schiedam, Holland, for the Royal Dutch Navy, the first of two such minelayers in erection at their yards.

Steel screw shelter deck steamer Atxerimendi, 340 feet long, by the Ropner Shipbuilding & Repairing Company, Ltd., Stockton-on-Tees, for Messrs. Sota & Aznar, Bilbao, Spain.

The Cunard liner Samaria, the largest ship ever built on the Mersey, by Messrs. Campbell-Laird & Company, Ltd., Birkenhead, England; 623 feet long, 21,000 tons.

Tonnage Output on Clyde

Twenty-five vessels, aggregating 47,837 tons, were launched from shipbuilding yards on the Clyde in November, which brought the total production for the year up to 540,214 tons. Although the month's figures are below November last year, the output exceeds that of the eleven months of 1919 by 36,559 tons.

New Passenger Liner

The fastest Diesel-drive passenger liner in the world will be constructed for the Swedish-American Line in Gothenburg, Sweden, and will be placed in service some time in 1922. The vessel will be 590 feet long, with a beam of 72 feet, and will have accommodations for about 1,500 passengers, including first, second and third class. To attain a speed of 18 knots, machinery of 16,000 indicated horsepower will be installed.

The Situation in England

Sir George Hunt, chairman of Swan, Hunter & Wigham Richard, speaking at a meeting at Wallsend, recently, expressed the opinion that a period of slackness was before the shipbuilding industry in Great Britain. He stated that the depression might not come suddenly owing to the large amount of work still on hand, but for every new order now being placed shipowners were trying to cancel two others. The reason, he said, was the appalling cost of building new tonnage and unless that was reduced, the shipbuilding industry could not reach its former high standard.

TRANSFERS OF VESSELS

Kentucky, steam screw, 43 tons, Daniel R. Ludwig to Daniel Frank Ludwig.

Kermite, steam screw, 22 tons, American Ship & Commerce Corp., to Kermit Roosevelt.

Monk Girls, barge, 45 tons, W. F. & R. Boat Inc., to Thomas Monk, Jr.

Norfolk, barge, 164 tons, Philip Rice, owning 2/3, Edward S. Johnson, 1/6th.

C. H. Marchal, steam screw, 60 tons, Charles R. Stewart and William W. Gearhart to Staten Island Ship Building Co.

Clermont, steam paddle, 1,174 tons, estate of George W. Perkins to Commission of the Palisade Interstate Park, $553,827.

Onteora, steam paddle, 771 tons, estate of George W. Perkins to Commission of the Palisade Interstate Park.

Cockatoo, steam screw, 101 tons, U. S. Shipping Board to Goodwin-Gallagher Sand & Gravel Corp.

Catherine Moran, steam screw, 80 tons, Moran Towing Line to Alpha Towing & Transportation Co.

Jim Hughes, barge, 492 tons, W. F. & R. R. Boat Builders, Inc., to James Hughes, Jr.

John T. Donahue, steam screw, 140 tons, Great Northern Paper Co. to Wm. C. Bickel and Lester A. Forsyth, $20,000.

Rachel Stevens, schooner, 1,032 tons, Minnie Goodrich, 1-64, to Fields Pendleton.

William H. Gallison, steam screw, 29 tons, U. S. Marshal to John J. Ascher, $7,300.

Ditto, John J. Ascher to Daly Towing Line, Inc.

NEW INCORPORATIONS

Colonial Steamship Corp., Manhattan, $25,000; F. J. Kandt, J. G. Kresge, F. A. Haight, 50 Broad street.

Danzig Line, Manhattan, navigation, $5,000; L. W. Simmons, G. N. Richards A. F. Egelhoff; no address.

Commonwealth Commerce Co., Manhattan, steamship brokerage, $10,000; R. Souffront, E. T. Eustis, G. D. Carrington, 120 West 11th street.

Portuguese State Maritime Corp., Manhattan, navigation, $5,000; L. W. Simmons, G. H. N. Richard. A. F. Egelhoff; no address given.

Victor Wilusz International Steamship Ticket Agency, Jersey City, $100,000; Alexander B. Ceiciuch, R. W. Dluswieswiski Victor Wilusz, Jersey City.

Seven Seas Corp., $1,000,000; Thomas P. McKee, Elmer F. Powell, Newark, N. J.; Frederick C. Bruckner, New York.

Robinson & Stevens, Inc., Central Park, N. Y., $10,000; contracting and stevedoring; J. W. Robinson, Edwin A. Stevens, Maud A. Robinson, Central Park.

Wordenship Corp., Delaware, $100,000; T. L. Croteau, M. A. Bruce, S. E. Dill, Wilmington.

McEvoy Mechanical Device Corp., Manhattan, machinists and shipbuilders, $5,000; J. A. Trimble, R. A. Barton, H. D. O'Hara, 524 West 145th street.

Naval Stores Corp. of New York, Manhattan, general merchandise, $10,000; D. L. Crowley, P. S. Goldrich, S. W. Kroll, 116 Nassau street.

McCarren Towing Line, Newark, $100,000; Daniel McCarren, Daniel McCarren, Jr., Lida A. McCarren, Newark.

Robert Roork, Camden, ship chandlers, $125,000; Robert S. Roork, Edward West, Orlando M. Bowen, Camden.

Dur-Hut Transportation Comapny, boats $450,000; T. L. Croteau, M. A. Bruce, S. E. Dill, Wilmington.

G. M. Luix Steamship Co., agents, $100,000; Antonio B. Camara, Oscar M. Malleeler, James J. Suludes, New York.

Doscher Transportation Corp., Manhattan, stevedore, $10,000; C. McLennan, M. E. Wood, H. Doscher, 117 Greenwich street.

McCormack Stevedoring Co., Manhattan, $10,000; R. W. Burker, H. Hampel, T. F. Fay, 438 Third street, Brooklyn.

North American Lloyd, Wilmington, Del., Charles B. Bishop, A. M. Fox, R. H. Ochletree, Wilmington.

Seacraft Corp. of California, Los Angeles, $250,000; E. A. Featherstone, Dustin Farnum, H. E. Roach, R. Thomas, Harry C. Keefe, J. A. Talbot and Marco H. Hellman.

Great Lakes & Atlantic Transit Co., Inc., Wilmington, Del. To build, own and operate boats; cap., $15,000,000.

Changed from North American Lloyd, Inc., to the Amalgamated Maritime Corporation of America, Wilmington, Del.

F. W. Freeborn Engineering Corporation, Wilmington, Del. A general engineering business; cap., $500,000.

MacLebee Electric Co., Wilmington, Del., Manufacture and installation of electrical motors and devices; cap., $300,000.

Robson Raft and Lifeboat Corporation, Boston, $200,000; Robert Dobson, James R. Glassford and Everett W. Flint, Boston.

Consolidated Fuel and Transportation Co., $5,000,000: T. L. Croteau, M. A. Bruce, S. E. Dill, Wilmington.

Dur-Hut Transportation Co., Wilmington, Del.; to own and operate boats; $450,000.

Bowe-Mortons Stores, Brooklyn, N. Y., wharfage and warehousing, $70,000; H. B. Gayley, H. J. Mayer, H. M. Samson 149 Broadway, N. Y.

J. V. Petrie & Son, Manhattan, shipbuilding $10,000; A. A. Fox, S. V. and J. V. Petrie, 178 Prospect Park West, Brooklyn.

DESIGNATION

Charbonneau, Rajola & Co., Del., ocean carriers, $100,000; rep., A. Charbonneau, 52 Broadway.

T. A. Scott Co., Conn., Marine Construction and Transportation, $150,000; rep., G. V. Reilly, 65 Cedar street.

Collieries and Commerce Corporation, Va., ship coal, $100,000; rep., T. K. Schmuck, 27 William street, Manhattan.

Auditore Steamship Line, Delaware; 10,000 shares common stock, no par value. Rep., J. G. Stockham, 2 Stone street, Manhattan.

Marine Construction News of the Month

Ship Contracts—New Ship Concerns and Shipyard Improvements—Terminal Projects—Government Contracts

SHIPS AND SHIPBUILDING

Tankers, Victoria, B. C.—The Harbor Marine Company is reported to be negotiating for the construction of four 8,000-ton steel tank steamers for Peruvian interests.

Active Production, Mobile, Ala.—All six ways of the Chickasaw Shipbuilding & Car Company's plant, are accupied with hulls under course of construction.

Pleasure Boat, Mobile, Ala.—James A. Campbell, will build a pleasure boat, 110 feet long, 22 feet wide, and to cost $30,000, for the Daphne Boat Company of Mobile.

Lake Passenger Ship, Cleveland, Ohio.—The Cleveland & Buffalo Steamship Company, operating passenger ships between Cleveland and Buffalo, is awaiting a more favorable time to build a new vessel to replace the City of Buffalo.

Repairing Vessels, Pensacola, Fla.—The Pensacola Shipbuilding Company has been awarded contracts for repairing and rebuilding three vessels recently damaged by fire at Galveston, Tex., aggregating an expenditure of $1,000,000.

Oil Tankers, Prince Rupert, B. C.—The Prince Rupert Dry Dock and Engineering Company, is reported to have received orders from the French Government for five steel oil tankers of about 6,500 tons each.

Pilot Station Boat, Baltimore, Md.—A new station boat for service at Cape Henry is to be built for the Maryland Pilots Association. Bids are under consideration at the Pilot Office, foot of Broadway.

Dreadnaught to Be Converted Into Liner—The Italian Dreadnaught Caracciola has been sold to the Navagazione Italiana to be transformed into a transatlantic liner, according to reports from London.

Barges to be Converted, Leith, Scot.—Henry Robb, Ltd., has received an order from an English firm for the conversion of five barges, each 240 feet long, into oil tankers, with a carrying capacity of from 1,000 to 1,500 barrels.

Steamer, Baltimore, Md.—The Baltimore Steam Packet Company, is in the market for a combination freight and passenger-carrying steamer to be called the Maryland. Plans and specifications have already been prepared, and are in the hands of several shipbuilders for quotations.

To Be Made Fruit Carriers, Philadelphia, Pa.—The Warden, Perry, Whipple, Truxton and Stewart, torpedo boat destroyers, sold as junk by the Navy Department, are being converted into fruit carriers by the Clinton Company of Philadelphia.

Vessel to be Repaired.—The contract for repairing the ship Rhine, which was seriously damaged several months ago by fire, has not been awarded, although bids were submitted by several Boston and New York repair concerns. The cost of repairs is estimated at about $100,000.

To Build and Operate Tankers, Baltimore, Md.—Interests in control of the Baltimore Dry Docks and Shipbuilding Company are said to have formed a $2,000,000 corporation for the operation of a fleet of four tankers which the company is to build at its plant for its own account.

Reconditioning Steamer, Oakland, Cal.—The Moore Shipbuilding Company was the successful bidder for the contract for reconditioning the steamer Enterprise. The ship is to be practically rebuilt, and a new engine purchased from the Shipping Board will be installed. The work will require several months, and will cost $186,000.

Auto Ferry Planned, San Francisco, Cal.—Plans have been drawn up for the construction of a double-decked ferry for the transportation of automobiles between San Francisco and Oakland, Cal. The craft will be equipped with Diesel electric motors, and will accommodate twenty-five automobiles.

Schooner Repairs, Oakland, Cal.—The Moore Shipyards have commenced repairs on the schooner Santa Monica, owned by John Hanify, San Francisco, which struck a bar recently. The schooner Fred Baxter, of the J. H. Baxter Company, is also at the yards undergoing a general overhauling.

Barge, Pittsburgh, Cal.—A contract has been let to Lanteri's Shipyard, for the construction of a water barge for the California-Hawaiian Sugar Company. The vessel will be 206 feet long, 52 feet beam and 14 feet deep, and will be used for carrying water between the river above Antioch and the refinery at Crockett.

Motorship Sold, Seattle, Wash.—The wooden motorship Kirketind was purchased by the Donovan Steamship Company, San Francisco, Cal., at a Federal Court sale at Seattle recently. The vessel was built this year at a cost of $400,000, but the sale price, it is reported, was only $153,000. The purchasers will put the vessel in the lumber carrying trade.

Hulls to be Converted into Barges, Portland, Ore.—A project is under way to convert a number of Shipping Board hulls into barges, and to operate a line of barges and tugs from the Columbia River and Puget Sound to New Orleans and the Atlantic Coast, according to William Shumm, traffic manager for the Pacific Coast Shippers' Association.

Converting Freighters into Tankers, Baltimore, Md.—The Globe Shipbuilding Company, is converting the freighters Manatawny, Cathahoula, Castana, Carraoulle and Casimir into tankers for private interests, which recently bought the vessels from the Shipping Board. The vessels are now having longitudinal bulkheads installed and the necessary angles and plates placed to enable them to carry crude oil.

Barges, Linnton, Ore.—Supple & Martin, who are operating the former shipyard of the Columbia Engineering Works, have been awarded a contract for the building of four 600-ton barges for the Crown-Willamette Paper Company. The barges will be of the spoon-bow variety, and will be used by the paper company to carry fuel from the lumber mills of the lower Willamette River to their plant at Camas, Wash.

British Contracts, South Shields, England.—The Smith's Dock Company, has secured the contract for converting the steamer Vaarili, of Bergen, from a cargo boat into an oil tanker. This boat was built in the United States in 1916, and is of 5,828 tons gross register. They have also on hand the oil tanker Strombus, belonging to the Anglo-Saxon Petroleum Company. This vessel was the last to be torpedoed and was heavily damaged her stern being completely blown away.

Additions to Olympic, Belfast, Ire.—Following her arrival at Southampton early in January, the steamship Olympic will be sent to the yard of Harland & Wolff, to have her oil bunkerage capacity increased. Oil storage tanks of 910 tons capacity will be installed in hold No. 1, and of 1,577 tons in hold No. 3, which will bring the ship's total bunkerage capacity up to 7,555 tons, or more than enough fuel for a round voyage. Her present capacity is 5,068 tons.

Plan to Build Submarines, France.—Plans of the French naval experts call for the construction of at least 100 high powered submarines. Officials of France are in accord regarding the superior value of the submarine over cruisers and battleships in the event of war, and while not intending to abandon entirely the building of new battleships, France will concentrate her efforts on building a submarine fleet which will figure her as a world naval power.

Reconditioning Steamer, Brooklyn, N. Y.—The Shipping Board has awarded the contract for overhauling and refitting the steamship Invincible to the Tebo Yacht Basin Company. The contract calls for general voyage repairs and the replacement of the war emergency type of geared turbine with the electric drive; all work to be completed by Feb. 11, and to cost $82,474. The Invincible, which is a sister ship of the Eclipse, is the second of the Shipping Board fleet to have the electric drive installed.

Ferryboats, San Francisco, Cal.—Three ferryboats of the type used by the Key Route, San Francisco Bay, will be constructed by the Six-Minute Ferry Company, recently granted privileges in San Francisco and Oakland, Cal., and is capitalized at $3,000,000. Articles of incorporation have been filed by the Golden Gate Ferry Company, which plans to operate vessels between San Francisco and Sausalito, for which service two ferryboats will probably also be constructed.

Shipbuilding Activities at Beaumont, Tex.—The Beaumont Shipbuilding & Dry Dock Company, which recently enlarged its plant and made provisions for repairing steel as well as wooden vessels, is engaged in repair and construction work. A number of barges and other small craft are being built for private account. It is probable that the company will be called upon to convert a number of Ferris type wooden ships into oil barges, and this work will keep the plant busy for many months.

Tankers, Quincy, Mass.—The first of five bulk oil carriers, totaling nearly 60,000 deadweight tons, is soon to be launched at the Fore River plant of the Bethlehem Shipbuilding Corporation, Ltd. Two of these vessels, each of 12,600 tons, will be delivered to the Standard Transportation Company, of New York; the third, which is of the same tonnage, is for the Atlantic, Gulf & West Indies Steamship Company, while the two others of 10,600 tons each will become part of the Sinclair Oil Company's fleet.

New Ferryboat, Hudson, N. Y.—The Hudson and Athens Ferry Company, is to have a new ferryboat on the run next spring. The boat, which will replace the George H. Power, will be 115 feet long and 44 feet wide. It will be a double-ended propeller, with two decks, the main deck being used entirely for traffic. The hull will be built at Washburn, Wis., and will be brought across the lakes to Oswego, N. Y., where the engines, built by the Ingersoll-Rand Company, will be installed. It is hoped to have the boat in service on Memorial Day, 1921.

Fruit Steamers, Newburgh, N. Y.—The Choluteca, one of three similar vessels for the Cuyamel Fruit Company, has been launched at

the Newburgh Shipyards, Inc.—The vessel is especially constructed for the carriage of fruit and passengers from Central American countries. It is designed to carry a deadweight of 2,100 tons on a draft of 17 feet, and to have a cargo space of about 140,000 cubic feet. The vessel has accommodations for a maximum of 32 passengers, and is built to the highest class of Lloyd's Register and in accordance with requirements of the United States Steamboat Inspection Service.

Tankers, Japan.—It is reported that the Japenese Diet has appropriated 13,500,000 yen for the construction of tankers. Orders have been placed with the Kawasaki Dock Yard, the Yokohama Dockyard, and the Osaka Iron Works for several tankers each of 11,000 tons, and having a carrying capacity of 9,000 tons of oil.

Tankers, Wilmington, N. C.—The George A. Fuller Company Carolina Shipyard, having completed its contract with the Shipping Board, with the delivery recently of the 9,600-ton steamer Syros, is now engaged solely in the construction of oil tankers, the first of which will be delivered to British owners during January.

Transport. Tacoma, Wash.—A contract for the construction of a 10,000-ton transport has been awarded to the Todd Shipyards Corporation, and it will be built within the next twenty months at the Tacoma, yards of the corporation at a cost of $3,935,000. The vessel will be 484 feet long, and have a beam of 64 feet. It is understood that her speed will be about 16 knots and that she will be equipped with oil-fired boilers and turbine engines. This transport will be used to replace some of the more antiquated troop carriers that are being retired from the service of the Navy.

SHIPYARDS AND DRY DOCKS

Power Boats, Etc., Baltimore, Md.—The Ericson Marine & Air Craft, Ltd., will establish a plant for the manufacture of air craft and power boats.

Shipyard Addition, Alameda, Cal.—The Bethlehem Shipbuilding Corporation, Ltd., has completed plans for the erection of a one-story machine shop addition to cost about $30,000.

New Pier, College Point, L. I., N. Y.—The College Point Dry Dock & Repair Co. has let a contract for the construction of a new pier to the Robins-Ripley Co., 50 Church Street, New York.

New Boat Building Company, Memphis, Tenn.—F. O. Fletcher is interested in establishing a company for the manufacture of river boats. F. T. Rurrit and E. T. Hutchings, Louisville, Ky., are engineers.

Dry Docks—Favorable progress is reported in the construction of an 8,000-ton floating dry dock for the Federal Shipbuilding Company, Kearney, N. J., and a similar dock of 10,000 tons for the Sun Shipbuilding Company at Chester, Pa. The dry docks are of William T. Donnelly design.

Repair Rates Reduced, New York—The reduction of repair rates of both harbor and ocean-going vessels is announced by the Staten Island Shipbuilding Company. Other local shipyards have also reduced the cost of repairs, averaging from 6 to 10 percent.

Plant Being Dismantled, Providence, R. I.—The plant of the Lord Dry Dock Company, which was erected during the war to build Ferris type wooden vessels, is being dismantled and the equipment shipped to the company's shipyard at Weehawken, N. J.

Shipbuilding Machinery, North Tonawanda, N. Y.—The Disappearing Propeller Boat Corporation, Robinson Street, is arranging for the immediate installation of machinery at its new plant, at which it expects to begin operations in December. Neil Wilson is manager.

Shipyard Addition, New Orleans, La.—The Marine Iron Works, 1012 Magazine Street, is planning the construction of a new one-story machine and forge shop 75 by 115 feet, to cost about $75,000. A department for boiler work will be installed.

Enlarging Plant, Milwaukee, Wis.—The Nordberg Manufacturing Company is completing additions to its plant at Chicago and Oklahoma Avenues, which will cost about $150,000, and provide capacity for building of large Diesel-type engine units. The machine shop has been enlarged 180 x 200 feet.

Shipbuilding Supplies—Bids for the purchase of $15,000,000 worth of surplus material, located in the yards of the Shipping Board on the Pacific Coast, will be asked by the Shipping Board, it is announced by Admiral Benson. Some of the yard sites will also be sold after the material has been disposed of, it is reported.

Repair Plant, Green Bay, Wis.—C. Hartmann, formerly of the Hartmann-Greiling Company, is head of a concern which is organizing a drydock and ship repair plant at Green Bay. Work on the drydock will be completed next year. A power house, and stock of material, however, is available for repair work.

Shipyard to Be Sold, Jacksonville, Fla.—An agreement has been reached whereby the Bentley Shipyard, now owned by the eity of Jacksonville, Fla., will be sold to the Merrill Steven Corporation, for $315,150, to be used for putting an 8,000-ton dry dock in operation. A repair plant will be located on the property.

Ships and Dry Docks Burned, New Orleans, La.—Three vessels of the Shipping Board were destroyed and seven others damaged by a fire which swept the Jahncke Dry Docks, on December 16. Approximately 1,200 feet of wharfage was also destroyed, the property loss being estimated at $3,500,000.

New Shipyard, Europe—According to information received from the American Legation at Bucharest, a Jugo-Slav Syndicate, under Government supervision, intends to construct a large yard for building and repairing ships. The syndicate planning to undertake this project controls practically all the Jugo-Slav ships on the Danube and Save Rivers.

Shipyard Ready for Operation, Washburn, Wis.—The Anchor Shipbuilding Company has placed its new shipyard and dock in operation. It will build wooden vessels exclusively for the present. New equipment is being installed, including the construction of two oil-burning furnaces for plate and angle work. Three additional slips will be built during the winter. Robert Curr is general manager.

Shipyard for Revere, Mass.—The Shawmut Marine Company, 85 Devonshire street, Boston, Mass., expects next spring to develop a modern pleasure and commercial vessel (up to 200 feet) building and repair plant on its 900-acre property at Revere Mass. The company has changed its name from Britt Bros. Corporation, and has added several well-known business and professional men to its directorate.

Dominion Shipyard to Resume, Toronto, Can.—The plant of the Dominion Shipbuilding Company, which has been idle since the company went into liquidation several weeks ago, will be reopened, and the work of completing the two 4,000-ton ships, which were under construction for the Dominion Government, will be taken over by the Collingwood Shipbuilding Company, and will probably be finished by next summer.

New Purchasing Agent, New York—The Smith-Eiseman Corporation of America, 217 Broadway, iron, steel and machinery exporter dealing largely with French shipyards, has been appointed exclusive purchasing agent for the United States and Canada by the Chantier et Ateliers de St. Nazaire, Penhoet, of Paris. It will also be American selling agent for the company.

New Boat Building Company, Los Angeles, Cal.—The Seacrfat Corporation of California was recently incorporated with a capital of $250,000, and F. A. Featherstone as president and Marco Hellman as treasurer. The company has acquired the plant of the Marine Equipment Company at Wilmington, Cal., which it will improve with new machine and metal worker shops and shipways, it will specialize in the building of pleasure craft.

Repair Plant, Chattanooga, Tenn.—The Bible Sand Company, Richard Hardy, president, will construct ways costing $25,000, of the side haul type, with four cradles, each 35 by 25 feet, to run on tracks extending 100 feet in the water and 150 feet up the bank. The land foundations will be of concrete and the river foundations of broken stone. The company will build and repair boats, barges, etc., of a maximum size of 158 feet long, 32 feet wide and 1-foot draft. N. W. Bowden and H. B. Springer are the engineers.

Plant to be Enlarged, Esquimalt, B. C.—Yarrows, Ltd., the Canadian shipbuilding subsidiary of Yarrows & Company, of Scotstoun, Scotland, is planning extensive expansion of its plant. William W. Marriner, works manager of the English company, was in Victoria recently to look over the plant in order to be able to make a report on what extensions are required, having been greatly impressed with the large amount of work done by the plant and the vast possibilities of the Pacific Coast.

Plant Resumes Operation, Seattle, Wash.—The Elliott Bay Marine Construction Company, having leased the south half of the Duwamish Waterway plant of the Elliott Bay Shipbuilding Company, with option of purchase, has resumed operations as a repair plant. A new marine railway with three tracks, capable of handling vessels up to 800 tons, has been built in No. 1 slip. Two smaller railways, each of 150 tons, are being laid in No. 2 slip; No. 4 slip will have a marine railway for storing vessels, and No. 3 will be used for other purposes.

Drydock, Shops, Etc., Perth Amboy, N. J.—The Perth Amboy Dry Dock Company will soon install a new 10,000-ton electrically operated drydock at its plant at the foot of Broad Street. It will be 462 feet long and 117 feet wide, and will be capable of accommodating vessels up to 500 feet in length. Additional buildings to provide for extra equipment necessary for the repair and construction of vessels will include a one-story boiler, plate and angle shop, 70 by 108 feet; concrete and steel machine shop, 70 by 100 feet, and a forge shop 70 by 90 feet. It is expected that about 1500 men will be employed.

Dry Dock, Norfolk, Va.—The fourth section of the floating dry dock of the Norfolk Shipbuilding & Dry Dock Corporation, was launched recently, at the company's plant at Argyle Avenue, Brambleton. This section is 60 feet long by 80 feet wide, 11 feet deep to the deck, and 32 feet deep to the top of the wings, and will be operated by six centrifugal pumps of 2,600 gallons per minute capacity, which in turn will be operated by six electric motors of 20 horsepower each. This section will have a lifting capacity of 1,000 deadweight tons, and will accommodate a vessel of 5,000 gross tons. It will be connected with the present three sections in two weeks. The cost of construction of this section is estimated at $125,000.

Enlarging Plant, Seattle, Wash.—Consummation of a deal whereby the Barde Steel Products Corporation of New York will acquire the Ames Dry Dock & Shipbuilding Company's yard for a consideration of $1,250,000 is expected in the near future. While the transfer of the property has not been completed, it is reported that a full agreement has been reached between the two parties. The Ames plant is ideally located in Seattle for a terminal, and it is known that the plans of the new purchaser call for the active operation of two of the four building ways in the Seattle yard. During the war the Ames yard turned out a considerable number of the 8,800 deadweight ton cargo carriers of the West Inskip type.

Big Repair Plant, Philadelphia, Pa.—G. H. S. Rollason, vice-president of the Dry Docks & Ship Repairs Corporation, announces that his company has secured about 36 acres of land in Camden, N. J., with 1,020 feet of water front and proposes to build a modern drydock and repair plant. Three piers 500 feet in length, two of which can later be extended, two of which can later be extended to 600 feet in length and one to 900 feet in length when conditions in the port warrant such extension, are to be built, together with one dry dock of 10,000 tons capacity, one of 6,000 tons capacity, and one marine railway of 4,000 tons capacity. A complete equipment of buildings and machinery, a set of ways for

wood and steel river and harbor barge construction, one or two floating machine shops, derrick barges and a floating welding plant, are also to be pro ided. The company's offices are at 1214 Real Estate Trust Building, Philadelphia.

PORT IMPROVEMENTS

Docks, Etc., Palmetto, Fla.—The city, W. E. Mann, clerk, will proceed with the construction of the new municipal dock and piling protection.

Wharves, Beaumont, Tex.—The city will soon vote on $500,000 bonds to improve the wharves. Address the Mayor.

Sea Wall, Hull, Mass.—The town let contract for building a reinforced concrete sea wall on Grover avenue to B. Weston, Allerton, to cost about $15,000.

Dredging, Tampa, Fla.—W. C. Clarkson plans to dredge slip 1,450 feet long, 200 feet wide and 16 feet deep, involving 320,000 cubic yards of excavation, and to cost about $75,000.

Wharf, West Norfolk, Va.—Hastings Brothers, Seaboard Bank Building, will rebuild the wharf which was recently burned, and costing about $40,000.

Canal, New Orleans, La.—The Grand Isle Navigation Commissioners, Grand Isle, La., propose to construct a canal for the navigation of boats from New Orleans to other points.

Concrete Dock and Shed, Manchester, Tex.—A concrete dock and shed, to cost about $300,000, will be built on the Houston Ship Channel. Money is available for the work.

Terminals, Charleston, S. C.—The Charleston Port Terminals, Inc., has been organized with a capital of $100,000 by J. Ross Hanahan and Joseph M. Whitsitt. They have leased terminals, including dock, headhouse and warehouse.

Piers, Equipment, Etc., Jacksonville, Fla.—The city plans to build a pier with warehouses, loading and discharging facilities, railroad tracks, cranes, engine, etc., in the St. Johns River, to cost about $1,000,000.

Bulkhead, New York—The Lehigh Valley Railroad, 143 Liberty Street, let contract for making the necessary repairs to the bulkheads along the North River to Barney-Ahlers, 110 West 40th Street, New York, at a cost of about $100,000.

Japanese Harbor Improvements, Yokohama, Japan—The harbor officials will spend about $7,000,000 for improving that port. Plans are also being prepared for improving and constructing new piers at Kobe, Shimonoseki and Kurztsu.

Salvage Equipment, San Francisco, Cal.—Four 1,000 horse-power tugs now nearing completion at the Main Iron Works have been equipped with heavy derricks and other gear for salvage work, for the Shipowners' & Merchants' Tug Boat Company.

Wharf, New Orleans, La.—The Dock Board is having plans and specifications made, and will soon receive bids for the building of a 1,200-foot creosoted timber wharf to replace one recently destroyed by fire at an estimated loss of $250,000. H. N. Gallagher, foot of Canal street, is chief engineer.

Absecon Inlet—Recommendation for $105,000 in the rivers and harbors bill, now being prepared, is being advocated for Absecon Inlet, Atlantic City, N. J., by a board of engineers. Bulkheading for the municipal ship terminal was completed this week, and work on the wharves will begin at once.

Deepening Harbor, Miami, Fla.—Deepening of the harbor of Miami to 25 feet, in order that larger vessels may touch at that port, will be asked of Congress. The present depth of the harbor is 20 feet, but increased business at the port, it is stated, calls for facilities for larger vessels.

Marine Terminal, Havana, Cuba.—It is reported that the Appalachian Corporation, New Orleans, La., will construct a warehouse and marine terminal at Havana. Plans have been made for the acquisition of a tract of waterfront property on Ha ana Bay, with sufficient wharf frontage for about 12 ships.

Dredging, Port Tampa, Fla.—The Atlantic Coast Line Railway Company, Atlantic Coast Line building, Wilmington, N. C., plans to dredge the channel at Port Tampa to a depth of 27 feet, involving 50,000 cubc yards of rock and 37,120 cubic yards of earth excavation. J. E. Willoughby is chief engineer.

Steel Crane Runway for Pier, Worcester, Mass.—The Morgan Construction Company, 15 Belmont Street, let contract for building a steel crane runway 250 feet long and 60 feet wide on concrete piers at their Crescent Street plant, to the Eastern Bridge and Structural Company, 88 Crescent Street; about $25,000.

$1,000,000 Shipping Terminals, Memphis, Tenn.—According to the Chamber of Commerce, the Federal Government and the city of Memphis, Tenn., will spend a total of $1,000,000 in the construction of shipping terminals in the vicinity of Harahan Bridge, which spans the Mississippi at Memphis, making the city one of the great inland ports of the country.

Wharves, Lords Cove, N. B.—The Department of Public Works, Ottawa, Canada, has let a contract for the building of a wharf at Deer Island, to F. L. Boone, South Devon, to cost about $20,000. A contract for building a wharf at Owen Sound, Ont., was also let to E. Conroy, Peterboro, amounting to about $18,000, on a cost plus percentage basis.

Pier, Breakwater, Etc., Missoula, Mont.—The Missoula Light & Water Company, Masonic Temple Building, plans building of a concrete and steel per, 150 foot breakwater, etc., involving the expenditure of about $20,000. J. C. Philips, secretary, Power Engineering Company, 621 Metropolitan Life Building, Minneapolis, Minn., engineers.

Terminals, Equipment, Etc., New Orleans, La.—More than one-third of a mile of additional waterfront facilities, equipped with the most modern loading and unloading devices, will soon be turned over by the United States Government to the port of New Orleans, La., according to W. O. Hudson, president of the Board of Commissioners of the port.

Piers, New York—The Department of Public Markets, Municipal building, plans to build a 1,000-foot pier at Thirty-ninth street, Brooklyn, to cost about $1,500,000; a 1,000-foot pier at 150th street and Harlem River, Bronx, to cost about $1,500,000, and four 1,000-foot piers on Gansevoort and West Washington streets, to cost about $5,000,000 all to be used as markets.

Wharves, Charleston, S. C.—Work has been started on the waterfront property of H. F. Barkerding and his associates, adjacent to the Clyde Liner terminals on the north. Plans include the building of new wharves, which will extend to the same head lines as the Clyde terminals. The slip will be dredged and generally improved along with the other work, which is in charge of the Jefferson Construction Company.

Terminal Contract Award Held Up, Weehawken, N. J.—Although the plans have been completed for the construction of a $30,000,000 freight terminal at Weehawken, N. J., the Cunard Line is holding up the award of contracts until the prices of material and labor are lowered. It is probable, however, that work on this project will be started next spring or summer. Dredging of the waterfront to a depth of about 35 feet is now in progress.

Port Terminal, Wilmington, Del.—The development of the Lobdell Tract along the Christiana as a part terminal will be started next spring. Preliminary work has been completed on the harbor plans, and from now on the concrete building of a bulkhead, storage houses and rail lines will be pushed as rapidly as it is possible for the engineers to get out drawings. The City Council has appropriated $2,000,000 for this work.

Deepening Channel, Locks, Etc.—Seattle citizens advocating the improvements to Lake Washington Canal have placed their suggestions before Col. Edward H. Schulz, of the United States Engineers. They include dredging and deepening of the channels to Lake Washington, and to Puget Sound, improvements to the approaches to the locks, and the addition of a larger lock, which would make the waterway capable of accommodating the largest battleships as well as merchant marine vessels.

Dredging, Etc., North Portland, Ore.—H. L. Gilbert has completed his survey of the harbor, ordered by the Port of Portland Commission to determine the advisability of opening that waterway to navigation, and recommends a channel 300 feet wide and 25 to 30 feet deep from the mouth of the Willamette River to the upper end of Monarch Mill Dock; completion of a dam across the upper end of the slough, to create a still water basin, and donation of a site for a public dock by interests benefited by the improvements.

New Piers, Philadelphia, Pa.—George F. Sproul, director of wharves, docks and ferries, has made public the details of plans for the construction of a new city pier at Chestnut Street on the site of the old pier to cost about $500,000. It will be a double deck steel and concrete structure 80 by 550 feet, extending out to the pierhead line. The first deck will be equipped with accommodations for river steamboats. The second deck will be used as offices for the Department of Wharves, Docks and Ferries thus saving the city the annual rental of $12,900 now paid to the Philadelphia Bourse. The department also took over the old pier property north of Market Street extending to the new Cherry Street municipal pier. Those structures will be torn out and replaced by two modern combination piers equipped for use either as trans-Atlantic terminals or for coastwise and river traffic.

Terminal, Etc., San Francisco, Cal.—The Board of State Harbor Commissioners will ask for an appropriation from Congress for the dredging of the Islais Creek India Basin district as part of their plans for the development of this district into a first class ocean terminal, and industrial district. A series of solid-fill piers, contemplated, will be 1060 feet in width and vary in length from 1060 to 3000 feet. The piers which will extend from these solid-fill structures to the pier head line will be 3300 feet in width and 1100 feet in length. The sheds are planned to be of ample length so that the cargo of a vessel can be accommodated in the space behind its own berth. The Islais Creek channel, and the areas north and south of the channel extending from the waterfront into the bay will be dredged to a depth of at least 34 feet of water at low tide, in order to make this terminal accessible to ocean-going vessels. Ultimately the improvement will provide berths for forty-nine steamships each 500 feet in length, and six berths for vessels 300 feet in length.

GOVERNMENT WORK

Marine Railway—Specification 4254. The local navy yard at Pearl Harbor, H. T., received no bids November 17 for completing the marine railway.

Power House, Annapolis, Md.—The Navy Department, Bureau of Yards and Docks, Washington, D. C., is taking bids for a new power house at the Government plant.

Refrigerating Equipment, Brooklyn, N. Y.—Specification 4282, the Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to install refrigerating equipment in Building "F."

Electric Distribution System, Bar Harbor, Me.—Specification 4341, the Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to install an electric distribution system at the Naval Radio station.

Steel Hull.—The United States Engineer, War Department, Washington, D. C., let contract for

furnishing a steel hull for the dredge Grossette, at New Orleans, to the Nashville Bridge Company, Nashville, Tenn.; $23,400.

Quay Wall, Norfolk, Va.—Bureau of Yards and Docks, Navy Department, Washington, D. C., let contract for building a quay wall to H. P. Converse & Company, 31st Street & Colonial Ave., Norfolk. The work must be completed in 300 days, and will cost $234,909.

Naval Experimental Research Plant, near Vellevue, D. C.—The Navy Department, Washington, D. C., has awarded contract to the Boyle-Robertson Construction Company, Evans building, for a new naval experimental research plant to cost about $652,700, including equipment.

Concrete Dock.—Lange & Bergstrom, of San Francisco, Cal., were awarded a contract by the Navy Department for the construction of a 600-foot concrete dock at the North Island Naval Air Station. The contract amounts o $360,000, and work was started about December 15.

Dredging—The United States Engineer Office, 329 Custom House building, New Orleans, La., will receive until 11 A. M., January 10, 1921, sealed proposals for dredging in the Intracoastal Waterway between Mermentau and Calcasieu Rivers, Louisiana. Further information on application.

Dredging and Wharf Construction, Norfolk, Va.—The United States Engineer Office, Norfolk, Va., will receive sealed proposals until 12 o'clock, noon, January 7, 1921, for dredging in the Elizabeth River and constructing a timber wharf partially surrounding the dredged area. Further information on application.

Transport to be Converted, Hoboken, N. J.—The United States army transport Wright, recently delivered by the Hog Island yard, is being converted at the Tietjen and Lang yard, into a mothership for seaplanes and balloons. A well is being located on the after deck, 100 feet long, 40 feet wide and 33 feet deep. An inflated balloon may be carried by the mothership, while just aft of the well will be stowing space for other equipment. The Wright will have a plant for making gas to inflate the balloons, and other unusual equipment.

Ships to be started are the West Prospect, 11,000 deadweight, by the Los Angeles Shipbuilding & Dry Dock Company; Chopaka, 11,000 deadweight, by the Los Angeles Shipbuilding & Dry Dock Company; Lubrico, 10,000, by the Moore Shipbuilding Company; Swiftstar, Swiftwind, Swifteagle, Swiftlight, Swiftking, 10,000 deadweight ton tankers, to be built by the Northwest Steel Company at Seattle, with the understanding that they will be purchased upon completion by the Swiftsure Oil Corporation of New York; Lio, 10,200 deadweight, to be built by the Baltimore Dry Dock & Shipbuilding Company.

Government Program—Nine more keels are to be laid down for the Shipping Board before the Government's building programme will have come to an end. During the month of November five new vessels were started, four of which will be oil carriers. The keel was laid on the building berth for the 10,100 tanker Homer at the Alameda plant of the Bethlehem Shipbuilding Corporation. The Baltimore Dry Dock & Shipbuilding Company started the Tulsagus, 10,200 tons; the Los Angeles Shipbuilding & Dry Dock Company laid down the West Greylock, 11,000 tons; the Moore Shipbuilding Company started the West Tusten, 10,000 tons, and the Alameda yard of the Bethlehem Shipbuilding Corporation has entered upon the construction of a second 10,100-ton tanker.

Navy Contracts, Quincy, Mass.—It is announced by the Fore River plant of the Bethlehem Shipbuilding Corporation that the keel for the superdreadnaught Massachusetts will be laid soon after New Year's day. The vessel will have a length of 660 feet overall, 106 feet beam, and a displacement of 43,200 tons. She will have electric drive, engines of 60,000 horsepower, and a speed of 23 knots. The keel of the Lexington, a battle cruiser, will be laid soon after that of the Massachusetts. She will have almost exactly the same beam as the Massachusetts, but her length overall is to be 880 feet and her displacement 43,500 tons. Her engines, of 180,000 horsepower, will yield a speed of 35 knots under electric drive. Two unnamed scout cruisers with 90,000 horsepower engines and a speed of 35 knots, also will be built at Fore River in the coming year. They will be 550 feet long with 55 feet beam and are each to carry eight 6-inch guns. Keels are also soon to be laid for six submarine boats each 225 feet long. The yard can lay down eighteen submarines at a time.

TRADE PUBLICATIONS

Ocean Engineer.—Number 1, Volume 2, of the Ocean Engineer, published monthly by the Ocean Marine Engineers Beneficial Association Number 80, at 15 Whitehall Street, New York; this booklet is issued by the engineers and is devoted entirely to their interests. It contains a large variety of articles and information of value to the deep water men.

New Calendar.—The Youngstown Sheet & Tube Company, Youngstown, Ohio, is issuing a 1921 calender containing twelve two-color illustrations showing interesting processes in the manufacture of iron and steel.

Proper Stowage.—The proper stowage of export shipments is so important in successful export trade that the Bureau of Foreign and Domestic Commerce of the Department of Commerce has just published a special report on the subject, written by Thomas R. Taylor, who is now in charge of the Bureau's Latin-American Division. Its preparation was begun by Mr. Taylor while he was engaged with the Shipping Board, and it, therefore, contains data gathered through that service, and also some facts and figures compiled by the War Trade Board. Of direct interest to shipping concerns are chapters discussing the principles and methods of stowing, to secure maximum and volume, stowing to prevent damage or danger to the ship or crew, stowing to secure maximum speed and minimum cost, laws relating to the seaworthiness of vessels, and many other related subjects.

Dodge Catalogue.—The Dodge Sales and Engineering Company of Mishawaka, Ind., announces the publication of a catalogue on Dodge standardized elevators and conveyors. An interesting feature is the simple manner in which designs involving gearing are worked out, whereby almost any drive, whether for a conveyor, elevator or other speed reduction, can be picked out of tables; pitches, numbers of teeth and shaft sizes. All details are thus solved without any complicated calculations.

German Service Anniversary

The first anniversary of the American Line's passenger and freight service to Germany was reached during the voyage of the *Mongolia*, of that line, which sailed from New York for Hamburg on December 16. The first sailing in this service by which direct commercial intercourse with Germany was resumed after an interruption of more than five years was that of the *Manchuria*, December 20, 1919. Since then the two ships named and a fleet of American Line freighters have plied steadily to the German port.

Control of Government Ships

Secretary of the Navy Daniels has asked Congress for legislation authorizing the Navy Department to direct operation of all Government vessels in time of war and for six months thereafter.

MARINE SOCIETIES

AMERICA

AMERICAN SOCIETY OF NAVAL ENGINEERS
Navy Department, Washington, D. C.
President—Capt. A. J. Hepburn, U. S. N.
Secretary-Treasurer—Commander J. S. Evans, U. S. N., Bureau of Engineering, Navy Department, Washington, D. C.
Annual meeting and election, first Tuesday in October, other meetings at call of the President.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS
29 West 39th Street, New York.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS
29 West 39th Street, New York City.

UNITED STATES NAVAL INSTITUTE
Naval Academy, Annapolis, Md.

NATIONAL ASSOCIATION OF MASTERS, MATES AND PILOTS
National President—John H. Pruett, 423 Forty-ninth St., Brooklyn, N. Y.
National Treasurer—A. B. Devlin, 187 Randolph Ave., Jersey City, N. J.
National Secretary—M. D. Tenniswood, 308 Vine St., Camden, N. J.

LIST OF OFFICERS, AMERICAN SOCIETY OF MARINE DRAFTSMEN
President—C. E. Deiser, 6124 Nassau Road, Philadelphia, Pa.
Vice-President—E. H. Monroe, 902 Virginia Ave., Washington, D. C.
Secretary—B. G. Barnes, 970 High St., Bath, Maine.
Treasurer—J. B. Sadler, P. O. Box 987, Norfolk, Va.
Executive Committeemen—G. W. Nusbaum, Washington, D. C.; A. H. Haag, Narberth, Pa.; John Thomson, Bethlehem, Pa.

NATIONAL MARINE ENGINEERS' BENEFICIAL ASSOCIATION OFFICERS
National President—Wm. S. Brown, 356 Ellicott Square Bldg., Buffalo, N. Y.
National Secretary-Treasurer—Geo. A. Grubb, 356 Ellicott Square Bldg., Buffalo, N. Y.

CANADA

GRAND COUNCIL, N. A. OF M. E. OF CANADA
Grand President—E. Read, Rooms 10-12, Jones Building, Vancouver, B. C.
Grand Vice-President—Jeffrey Roe, Levis, P. Q.
Grand Secretary-Treasurer—Neil J. Morrison, Box 886, St. John, N. B.
Grand Conductor—E. A. House, Box 333, Midland, Ont.
Grand Door Keeper—Lemuel Winchester, 306 Fitzroy Street, Charlottetown, P. E. I.
Grand Auditor—W. C. Woods, Toronto, Canada.
Grand Auditor—J. C. Adams, 1704 Kitchner Street, Vancouver, B. C.

GREAT BRITAIN

INSTITUTION OF NAVAL ARCHITECTS
5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND
39 Elmbank Crescent, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS
Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS. INCORPORATED
The Minories, Tower Hill, London.

ITALY

COLLEGIO DEGLI INGEGNERI NAVAL E MECCANICI IN ITALIA,
Via Carlo Alberto 18, Genova.

Marine Engineering

Volume XXVI FEBRUARY, 1921 Number 2

Fig. 1.—View of Sir W. G. Armstrong, Whitworth & Company's Armstrong Yard from Airplane

One of England's Largest Shipyards

Description of Sir W. G. Armstrong, Whitworth and Company's Armstrong Yard at Newcastle-on-Tyne

FEW firms can claim the same wide experience in merchant ship design and construction as the Sir W. G. Armstrong, Whitworth and Company, Ltd. The diversion of the resources of the Armstrong Naval Yard, which has now taken the place of this firm's world-known Elswick yard, to the building of merchant ships is of considerable importance and adds considerably to the large shipbuilding facilities of the British Isles.

Figs. 1 and 6 show the general layout of the yard, which covers a total area of 83 acres. It is bounded on the western side by a branch line of the North Eastern Railway, which runs approximately parallel with the river at this point.

The Armstrong yard is capable of building about 70,000 tons of steel a year into ships, so that the maximum annual output of merchant shipping may be taken as about 140,000 gross register tons.

An inspection of Fig. 6 will show that the river frontage, which has a total length of 4,350 feet, is about equally occupied by the building berths and the fitting out dock. The latter, which has a total length of 2,133 feet, is constructed of reinforced concrete and terminates at its southern end in a reinforced concrete ground-head adjacent to the first building berth.

The length of the dock is sufficient to accommodate three large vessels placed end to end, and the river is dredged to give a minimum depth of 32 feet at low water for a width of 100 feet in front of the dock.

It will be noted from Fig. 6 that the larger building berths are situated in the central portion of the yard.

The platers' shop and frame shop are as near as practicable to the building berths, and the fitting shops, stores, joiners' shops and other departments mainly engaged on work on vessels after launching are close to the fitting out dock.

Berths

As originally laid out, the yard was provided with nine building berths, but another berth has since been added at the southern end and the other berths in that vicinity have been increased in breadth so that the smallest can now accommodate a cargo vessel of over 10,000 tons deadweight capacity. The largest berth is of sufficient size to permit the construction of a vessel 1,000 feet in length and 120 feet beam. Adjoining this is a berth capable of taking a vessel 900 feet long by 110 feet beam, and the next berth can take a ship 800 feet long by 100 feet beam. The maximum dimensions of vessels that can be built on the seven remaining berths are all shown on Fig. 6. The three largest berths were designed for battleship construction and were therefore spe-

Fig. 2.—Panoramic View of Armstrong Yard,

cially strengthened by timber piling, a fact which makes them quite suitable for the construction of the largest and heaviest merchant vessels yet contemplated.

Cranes

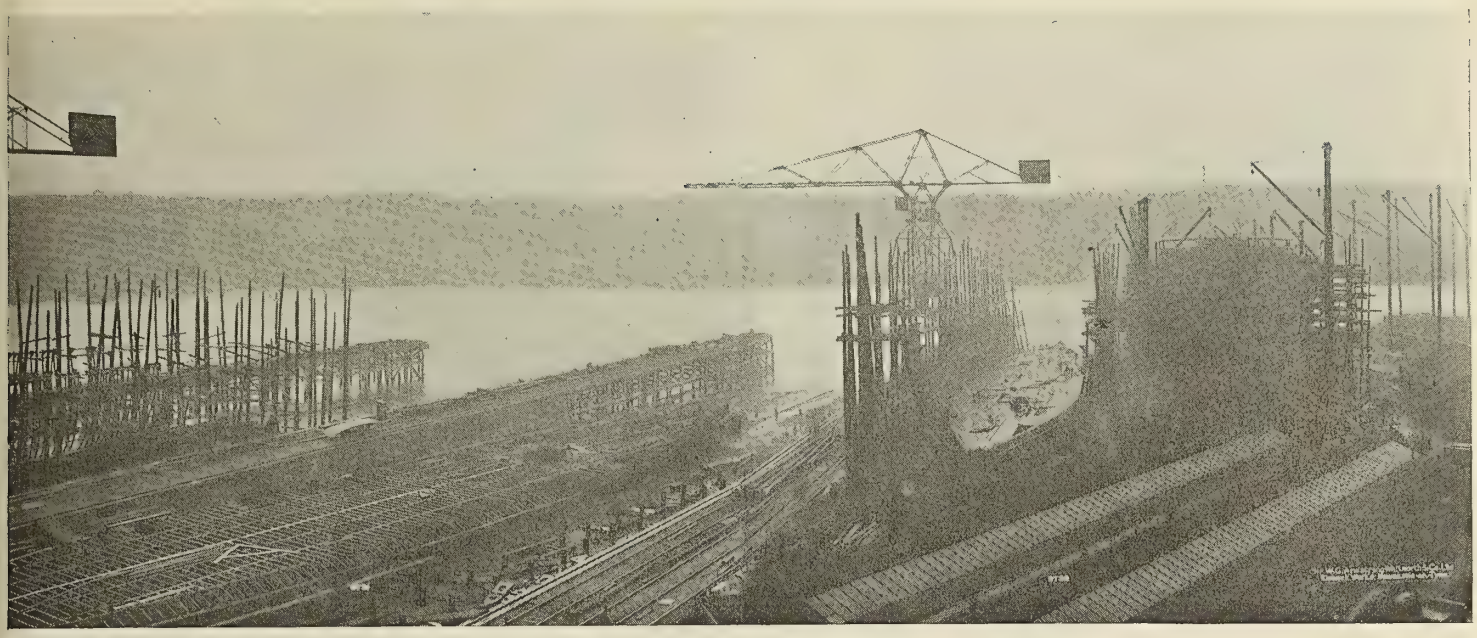
The crane equipment of a large shipbuilding yard is obviously a matter of the utmost importance, and this question was very carefully considered in laying out the Armstrong yard. The yard is at present equipped with nine electric traveling tower cranes, two of which are kept on each of the three jetties between the first four berths and another works on the fitting out dock. These cranes are designed to handle a load of 5 tons at a radius of 120 feet and a load of 10 tons at a radius of 60 feet. A clear lift of 90 feet above rail level is obtained.

The hoisting speed for a 5-ton load is 100 feet per minute, and a 10-ton load is hoisted at half this speed; the racking speed with a 10-ton load being 75 feet per minute and the traveling speed 80 feet per minute. In slewing, the cantilever arm makes a complete revolution in 2 minutes and the slewing motion is fitted with a special form of friction drive designed to absorb the shock to which the gearing might otherwise be subjected by a too sudden application of the brakes.

In addition to the traveling tower cranes, each of the large berths is provided with four electric winches with blocks and

Fig. 3.—Traveling Crane and Hydraulic Riveter

Fig. 4.—30-Ton Crane on Fitting-Out Dock



Showing Building Berths and Tower Cranes

tackle for shell work, and the six smaller berths at the southern end of the yard are each equipped with 10 masts and derricks with one electric winch for every two derricks. Most of the derricks are intended for loads of 3 tons, but 5-ton and 12-ton winches are provided here and there for specially heavy lifts. As shown in Fig. 6, a line of standard gage rails is laid between each of the smaller berths and 10-ton steam cranes operate on this line for general work. Seven of these 10-ton steam locomotive cranes are employed in various parts of the yard and there are also one 7-ton and three 5-ton and two 3-ton cranes of a similar type available for general use. One large shunting locomotive and four crane locomotives, capable of lifting 3 tons at the end of the jib and 5 tons at a smaller radius, are also employed in the yard.

Offices

The general offices are situated in a central position near the main entrance from Church street, Walker. Structurally the building is interesting on account of the fact that, in order to economize space, it was constructed on the embankment, so that it is six stories high on the yard frontage and only two stories high on the main entrance frontage. The building is a reinforced concrete skeleton structure 230 feet in length, its width being 122 feet at the top and 38 feet at the yard level. The height of the yard front is 100 feet and that of the entrance front 42 feet.

Entering the building through the main entrance a large model hall measuring 70 feet by 37 feet is first reached. To the left of this is the designing office, in which accommodation for about 30 designers is provided. From the model hall a corridor leads into a longitudinal corridor giving access to a number of large offices for heads of departments. The floor above the main floor is occupied by drawing offices, tracing offices and photo-printing rooms. About 150 draftsmen and 35 tracers are normally employed.

The floor below the main floor contains 30 offices occupied by overseers.

Dining accommodation for the whole staff, numbering about 400, is provided on the next lower floor. A kitchen, very fully equipped with electric cooking appliances, is also situated on this floor and the arrangements are such that about 300 luncheons can easily be served simultaneously.

The third floor below the main floor contains 14 offices occupied by yard officials, and below this is a mezzanine floor.

On the yard level the greater part of the floor space is occupied by the time office and the piece work office, but there are also a few offices for foremen and other rooms.

Platers' Shop

The most important of the shop buildings in the yard is undoubtedly the platers' shop, which is the largest of its kind in the country.

As shown on Fig. 6, the building is situated near the heads of the berths at the southern end of the yard and extends for nearly a quarter of a mile, terminating in front of the main office buildings.

Between the platers' shop and the embankment are the plate racks. Trucks containing plates are brought down the slope from the North Eastern Railway line by the yard locomotives, which haul them along the tracks under the gantry shown on Fig. 5. The trucks are here unloaded by two overhead traveling cranes, the plates being sorted according to

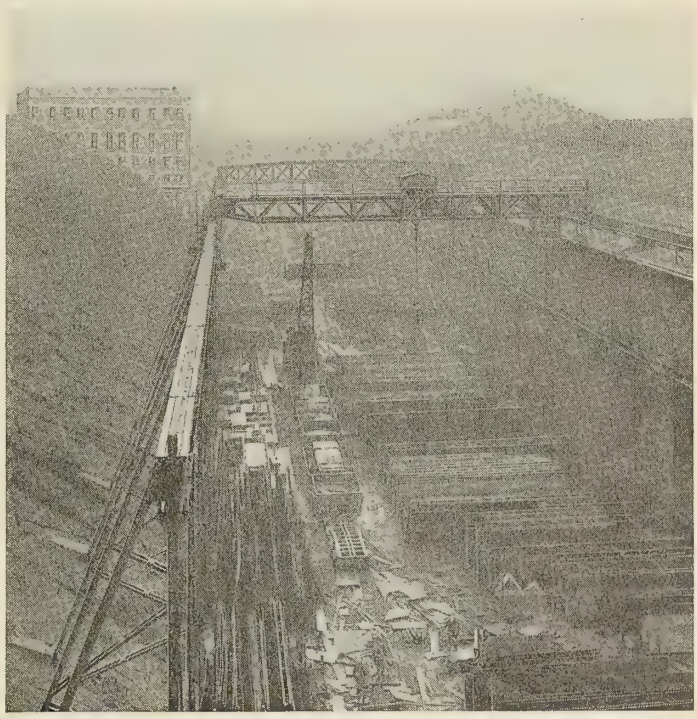


Fig. 5.—Plate Racks

size and thickness and placed in the appropriate racks. These cranes, each capable of lifting a load of 10 tons and of traveling laterally at the relatively high speed of 200 feet per minute, allow the largest plates to be easily and expeditiously handled. The crane rails, which are 48 feet 9 inches above the ground level, are supported on one side by the columns of the platers' shop and at the other side by a special steel gantry. The total length of the gantry is 1,120 feet and the span is 76 feet 6 inches between the centers of the crane rails. Two large pickling tanks are provided near the southern end of the plate racks.

Building

The platers' shop is a steel framed structure 1,200 feet in length and 150 feet wide, divided into three bays. The wing bays, it will be noticed, are each 52 feet in width, while the central bay is 46 feet wide. The shop is completely closed in on the sides with large sliding doors in convenient positions, so that work can be carried on in comfort in all weathers. The greater part of the roof and a considerable portion of the sides and ends are covered with glazing, the remainder being covered with corrugated sheets. This arrangement gives ample light in the daytime, as will be gathered from the interior views, and at night efficient illumination is provided by means of 2,000 candlepower half watt lamps.

Mold Loft

In an upper story at the northern end of the shop is situated the mold loft, Fig. 8, which extends over the eastern wing bay and the central bay. The floor dimensions of the mold loft are 320 feet in length by 98 feet wide, and the height to the spring of the roof trusses is 18 feet 9 inches, while in the center the height is 28 feet. The sides and ends are covered with corrugated sheets and glazing and the roof is partly glazed and partly covered with slates. Special attention was given to the construction of the floor in order to ensure a perfectly true surface, and for this reason specially selected Siberian pine was employed in planks 3 inches wide by 3 inches thick. A series of benches is arranged along the whole length of one side of the loft for making molds and templates, and the work is further facilitated by the employment of portable motor driven saws and other tools. The loft is well lighted both by day and by night, and in cold weather it is comfortably warmed by means of steam pipes.

Leading from the mold loft at the southern end, and extending over the central bay only, is a template storeroom measuring 35 feet by 80 feet. Access to the mold loft is obtained by a staircase 9 feet wide arranged in three flights having teak treads.

Cranes

The columns in the platers' shop are spaced 80 feet apart to give ample room for handling large plates. These columns carry longitudinal girders which support the crane tracks and the roof principals, the latter being spaced 20 feet apart.

There are three 10-ton electric, overhead, traveling cranes in each of the wing bays and two similar cranes in the central bay, the height of the crane rails above the floor level being 33 feet 4 inches in each case. These cranes are provided with independent motors for hoisting, traversing and longitudinal travel, the speed of the latter being 250 feet per minute. This speed, it may be mentioned, has been found as high as convenient in view of the fact that plates up to 45 feet in length have to be handled. Additional facilities for handling materials are provided by means of a large number of fixed hydraulic and hand operated cranes placed in convenient positions in proximity to the larger machine tools.

The usual method of handling plates is to lift them from the racks and bring them up to one of the sliding doors of the shop by means of one of the traveling cranes over the plate racks. They are then taken by one of the hydraulic cranes inside the shop to the straightening rolls, if required, and thence by means of the overhead cranes in the shop to the various machine tools. When the necessary operations are completed the plates are placed on railway trucks and hauled down to the berths by steam locomotives.

Arrangement

The layout of the shop is shown in Fig. 7. It will be noticed that the punching and shearing machines and other tools are arranged with ample space between them so that long plates can be operated on in one machine without interfering with the work at another tool. They are also, of course, arranged so that the various operations can be carried out in an efficient sequence involving the minimum possible amount of handling. In general, the heavier work is done at the northern end of the shop, the whole of the southern end being used for work of a lighter character. The central portion of the shop, as will be noted from Figs. 7 and 10, is free from machine tools, this portion being used for the laying out of decks and bulkheads.

Tool Equipment

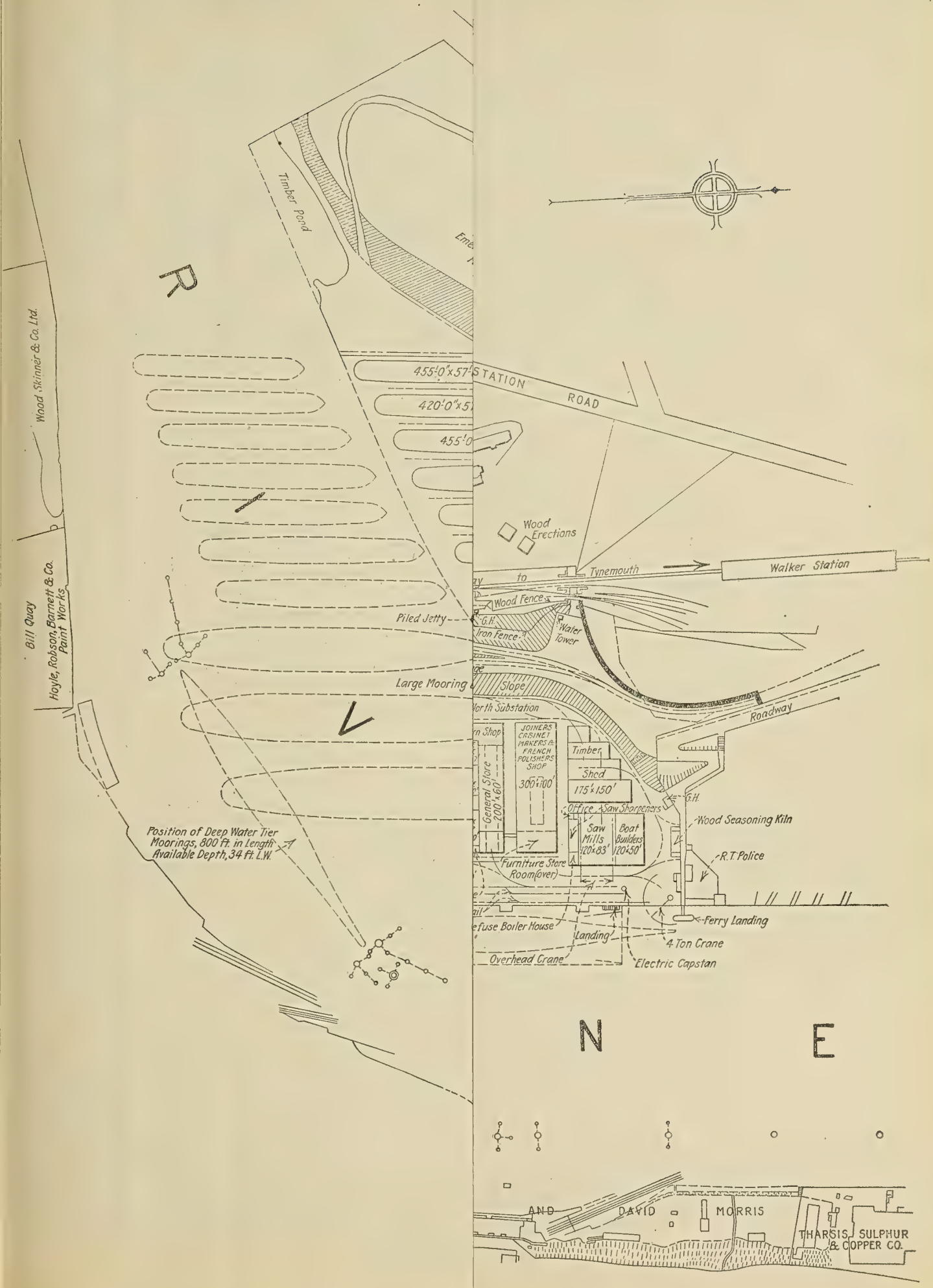
The tool equipment of the shop includes a variety of punching and shearing machines disposed as shown in Fig. 7. They are designed to punch holes up to 1½ inches in diameter through mild steel plates 1½ inches in thickness or up to 1¼ inches in diameter through high tensile steel up to 1¼ inches thick. The smaller machines are capable of working on mild steel plates up to 1 inch in thickness.

One of the machines is fitted with a manhole punch capable of cutting manholes up to 23 inches by 15 inches through ¾-inch plates. All the large punching and shearing machines are provided with 8-ton cranes of 23-foot rake, while the smaller machines have 5-ton cranes of 20-foot rake attached. Plate straightening rolls, or mangles as they are termed, are provided of various makes and capacities, the largest a four roller machine capable of dealing with plates up to 12 feet in width and up to 2 inches in thickness. Each mangle is served by a hydraulic crane of suitable capacity—in fact, all machines in which work has to be supported during the machining process are fitted with self-contained cranes.

In addition to the above-mentioned tools there are a number of radial drills, plate edge planers, joggling machines, etc., which form part of the equipment of all modern platers' shops and therefore call for no special comment. There are, however, a number of heavy tools which are worthy of more detailed treatment.

One of the most important tools is the large plate bending rolls situated near the center of the shop. This machine has a clear width of 41 feet 6 inches between the housings and is capable of working high tensile steel plates up to 41 feet in length and up to 2 inches in thickness. The three rollers are of forged steel, the upper one being 21 inches in diameter and the two lower ones 16½ inches in diameter. Each of the rollers is supported by three sets of roller bearings in addition to the journals at the ends, the bearings being mounted on brackets bolted onto heavy steel plate girders, as shown in Fig. 12. The upper roller and its supporting girder can be adjusted vertically, to alter the radius of curvature of the work, by means of screws operated by two 35-horsepower electric motors and worm gearing, and the lower rollers are fitted with sliding bushes so that they can be adjusted laterally to suit plates of different thicknesses. The lower rollers are both driven by a single electric motor of 260 horsepower by means of spur gearing. All the gearing, with the exception of the two large wheels keyed onto the roller journals and the pinions which gear with them, is of cast steel with machine cut teeth.

The main driving motor, which runs at 585 revolutions per minute, is of the totally enclosed, slip-ring type for three


Timber Pond
455'0"x57'
420'0"x5
455'0
STATION ROAD
Wood Skinner & Co. Ltd.
Bill Quay
Hoyle, Robson, Barnett & Co. Paint Works
Wood Erections
Tynemouth
Walker Station
Wood Fence
G.H.
Iron Fence
Water Tower
Piled Jetty
Large Mooring
Slope
Roadway
JOINERS CABINET MAKERS & FRENCH POLISHERS SHOP
300'x100'
General Store 200'x60'
Timber Shed 175'x150'
Office
Saw Sharpeners
Saw Mills 120'x83'
Boat Builders 120'x50'
Furniture Store Room (over)
Wood Seasoning Kiln
R.T. Police
Position of Deep Water Tier Moorings, 800 ft. in Length Available Depth, 34 ft. L.W.
Ferry Landing
Landing
4 Ton Crane
Overhead Crane
Electric Capstan
N
E
AND DAVID MORRIS
THARSIS SULPHUR & COPPER CO.

ONE OF ENGLAND'S LARGEST SHIPYARDS

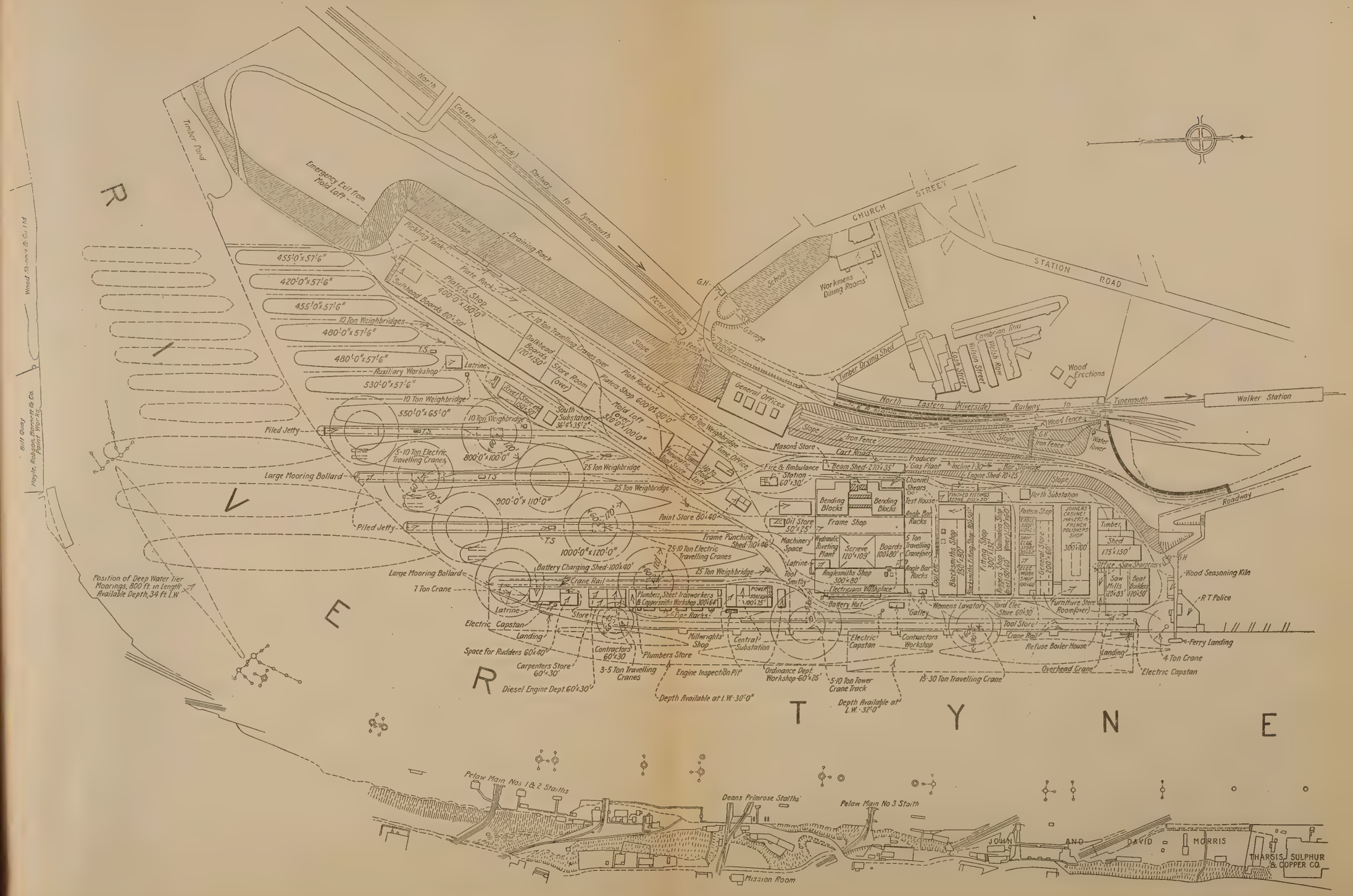


Fig. 6.—General Layout of Armstrong Yard of Sir W. G. Armstrong, Whitworth & Company, at Newcastle-on-Tyne

LIBRARY
FEB
INSTITUTE

PYARDS

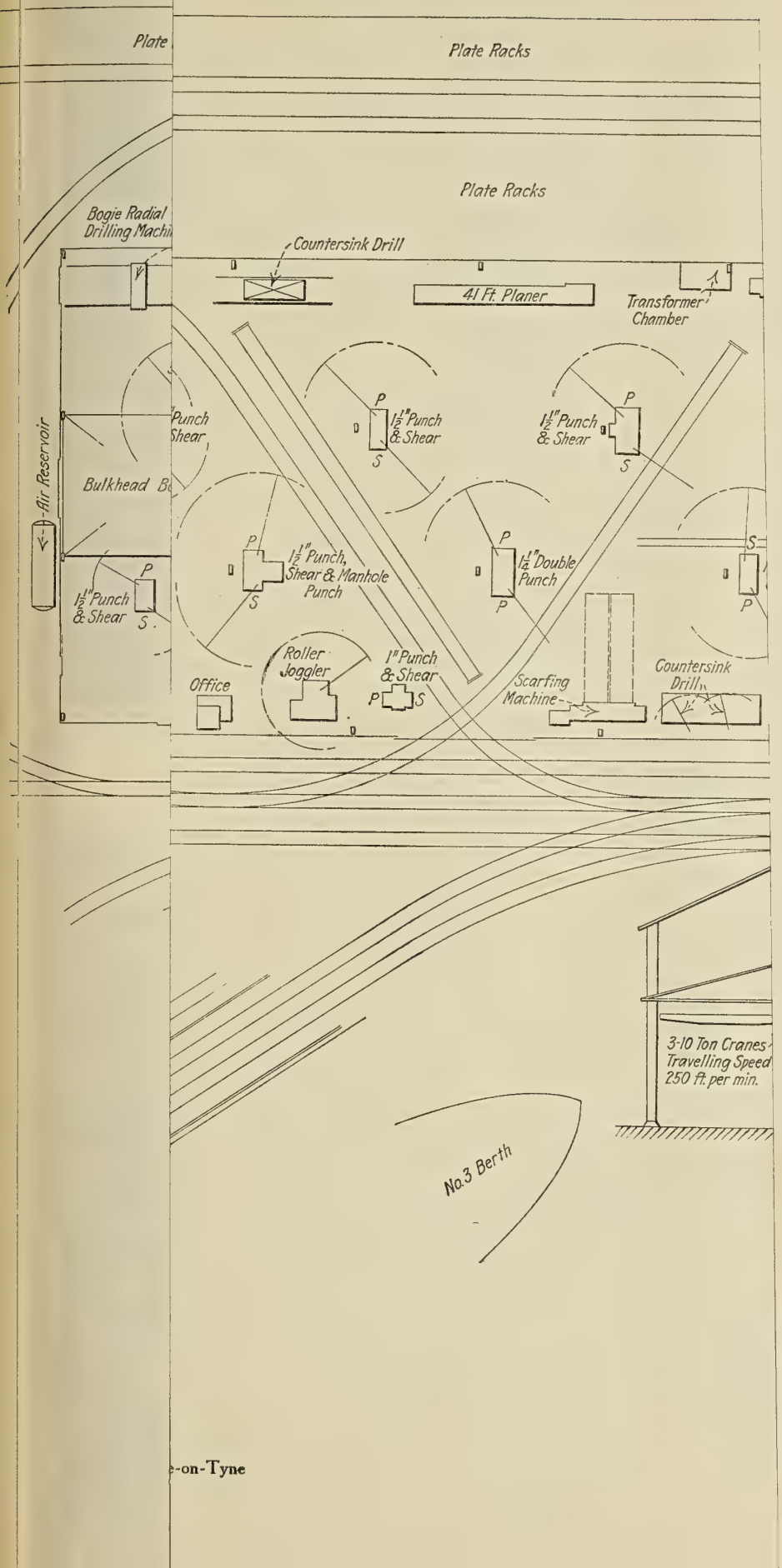


Plate
Plate Racks
Plate Racks
Bogie Radial
Drilling Machi
Countersink Drill
41 Ft. Planer
Transformer
Chamber
Punch
Shear
Bulkhead B
Air Reservoir
1½" Punch
& Shear
1½" Punch
& Shear
1½" Punch
& Shear
1½" Punch,
Shear & Manhole
Punch
1¼" Double
Punch
Roller
Joggler
1" Punch
& Shear
Office
Scarfing
Machine
Countersink
Drill
3-10 Ton Cranes
Travelling Speed
250 ft. per min.
No. 3 Berth

ONE OF ENGLAND'S LARGEST SHIPYARDS

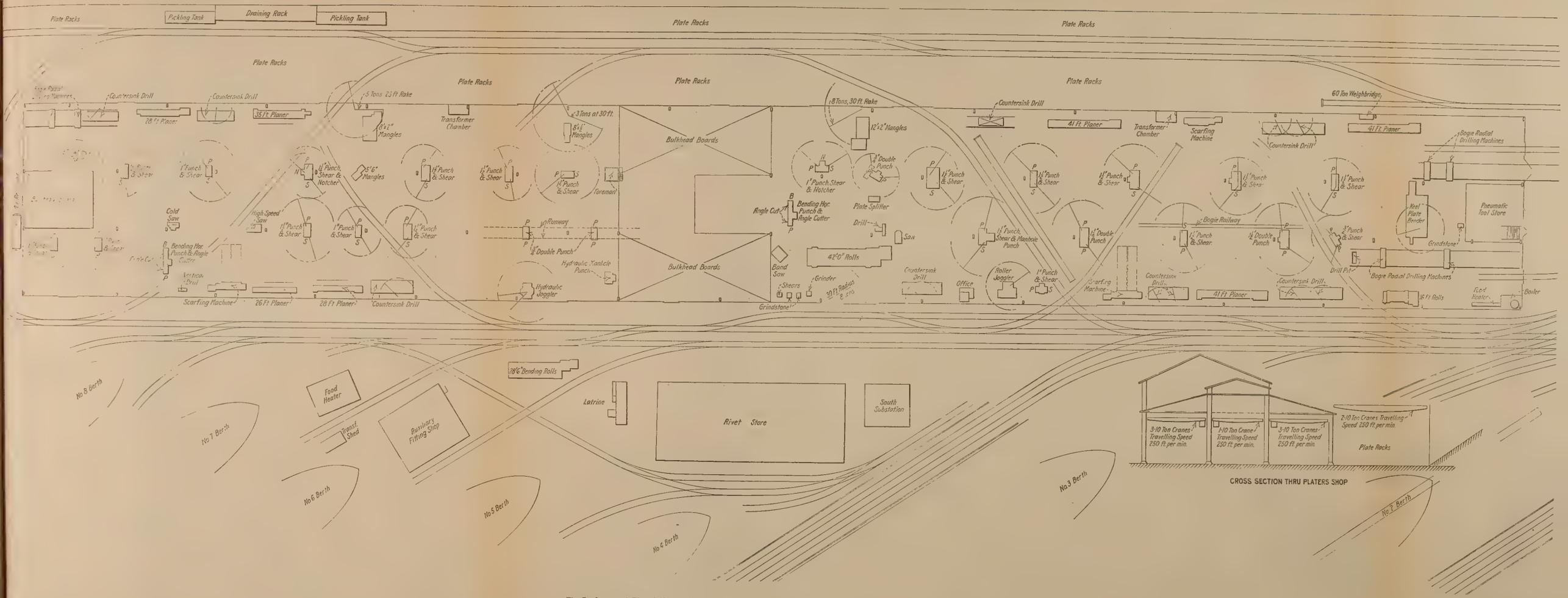


Fig. 7.—Layout of Platers' Shop at Armstrong Yard of Sir W. G. Armstrong, Whitworth & Company, Newcastle-on-Tyne

Fig. 8.—Mold Loft

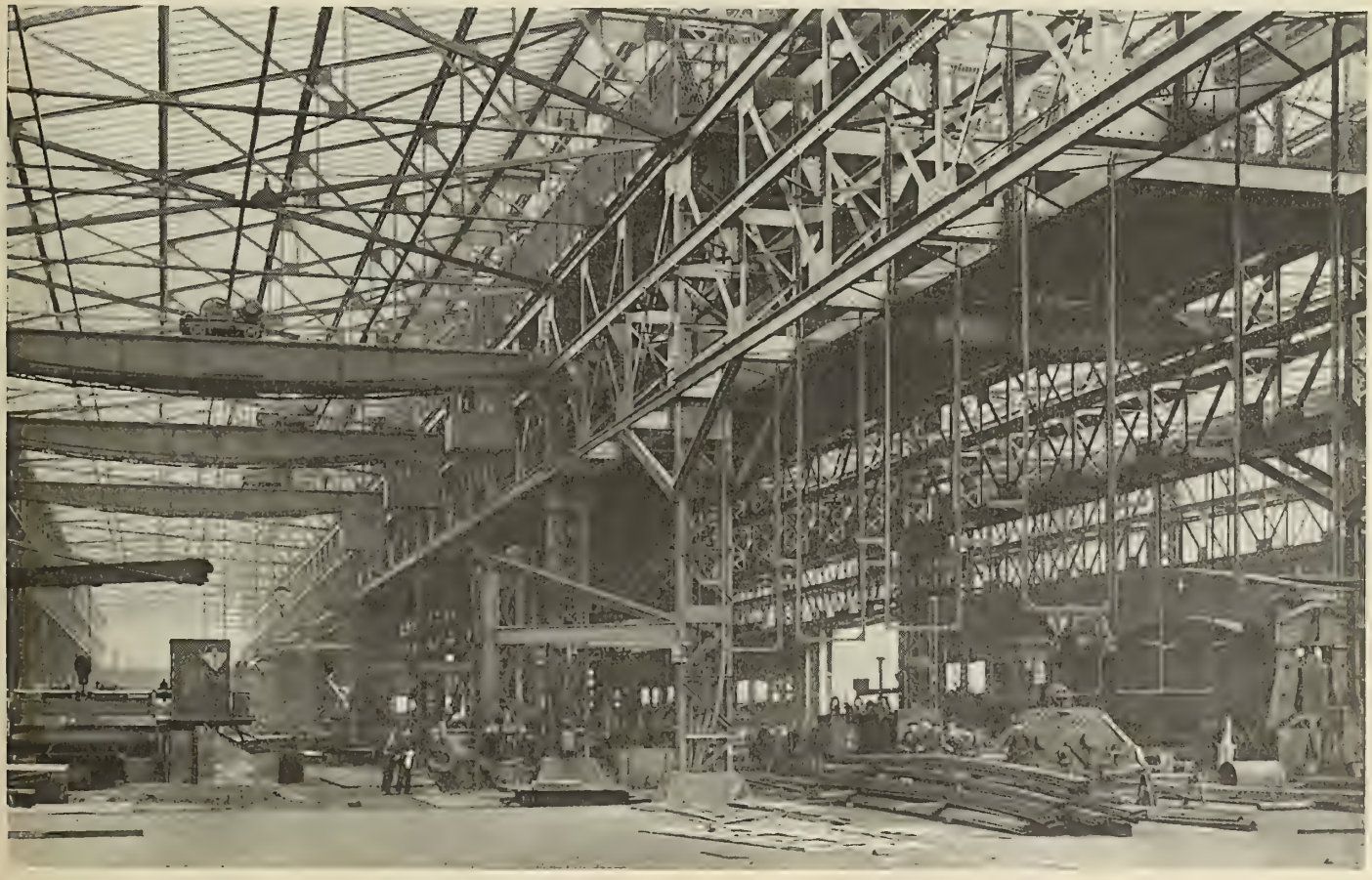


Fig. 9.—Platers' Shop, Looking North

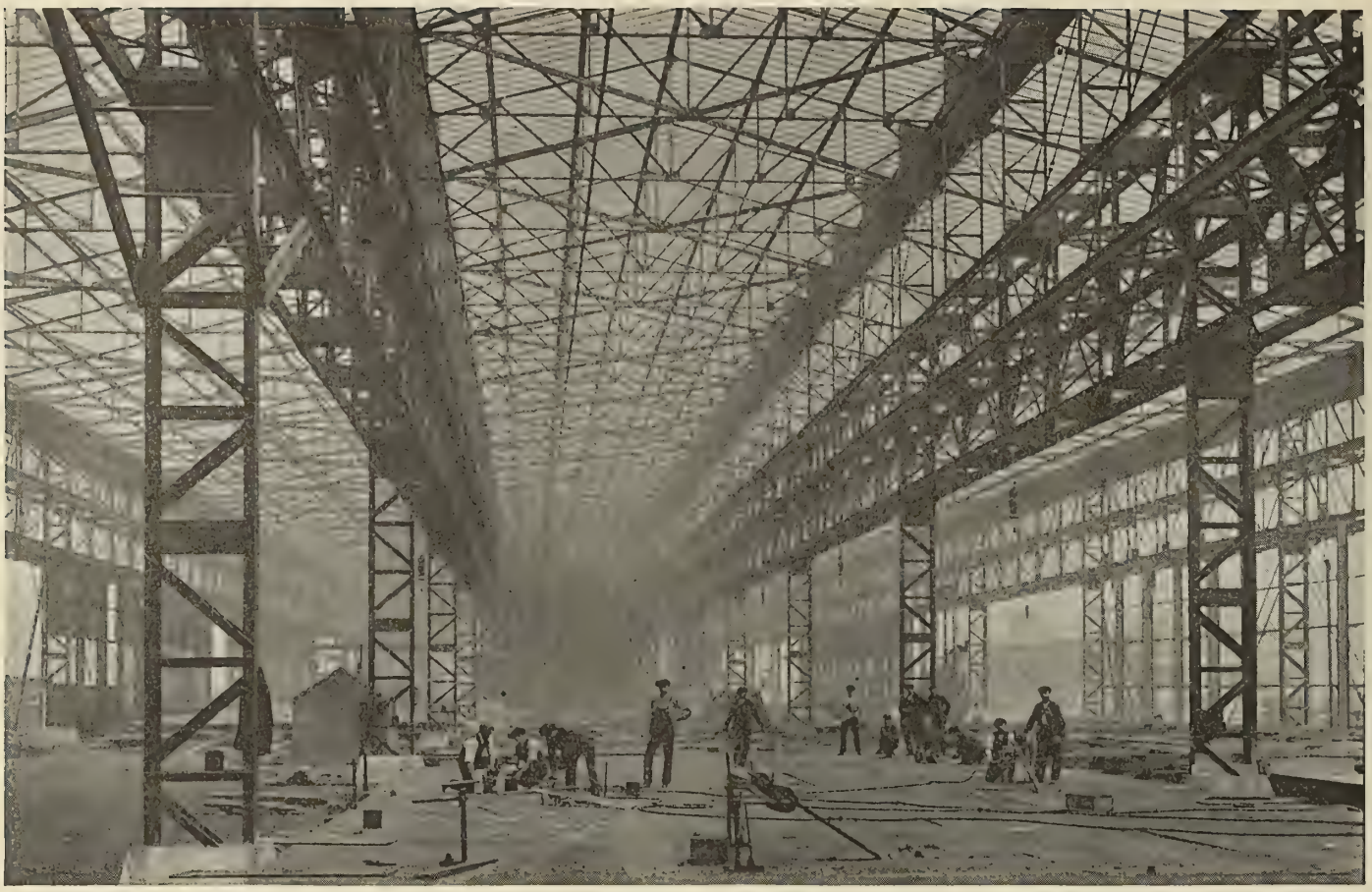


Fig. 10.—Central Portion of Platers' Shop, Used for Laying Out Decks and Bulkheads

Fig. 11.—Platers' Shop, East Bay

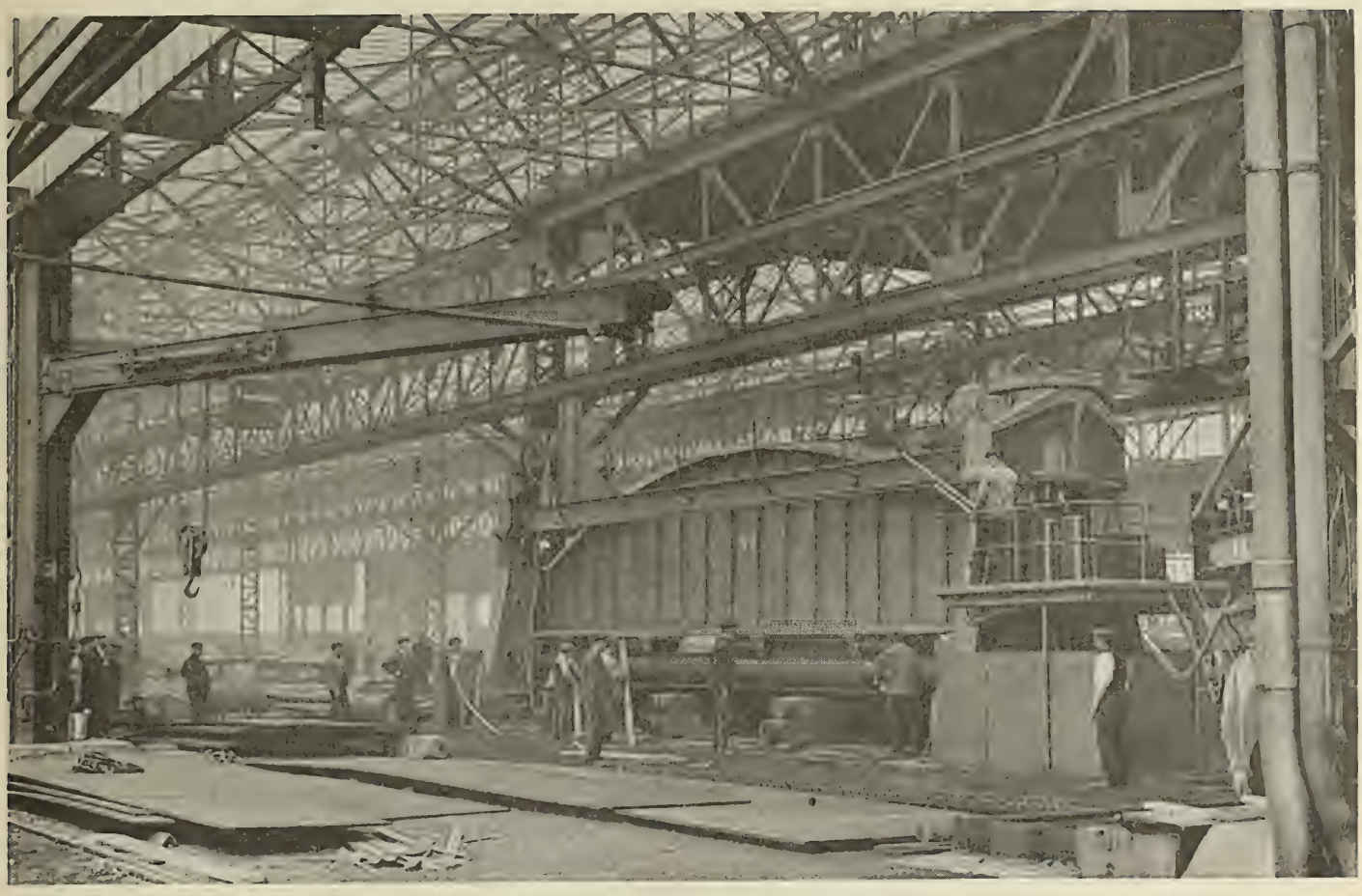


Fig. 12.—Large Bending Rolls in Platers' Shop

Fig. 13.—Platers' Shop, West Bay

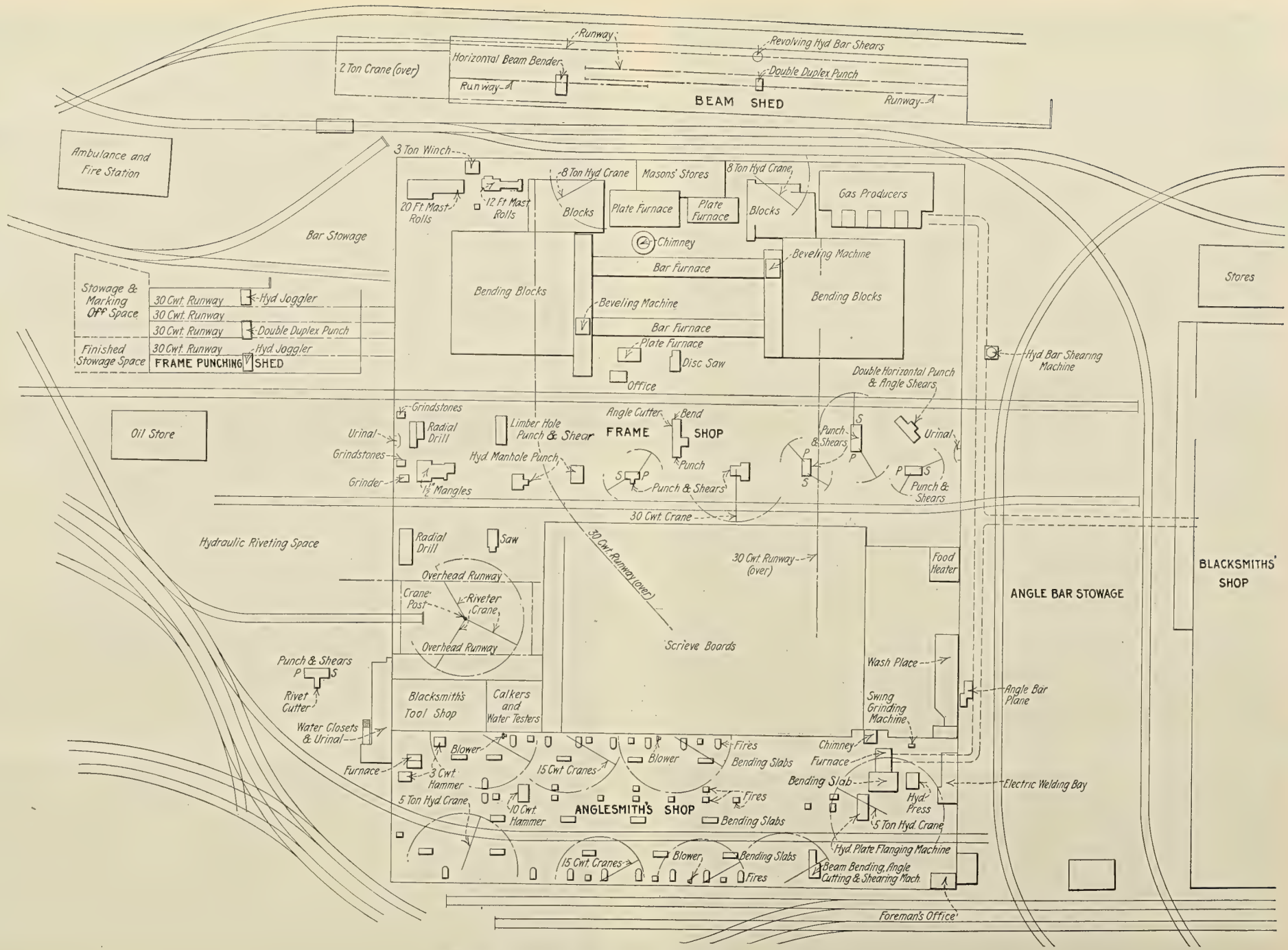


Fig. 14.—General Layout of Frame and Anglesmiths' Shops

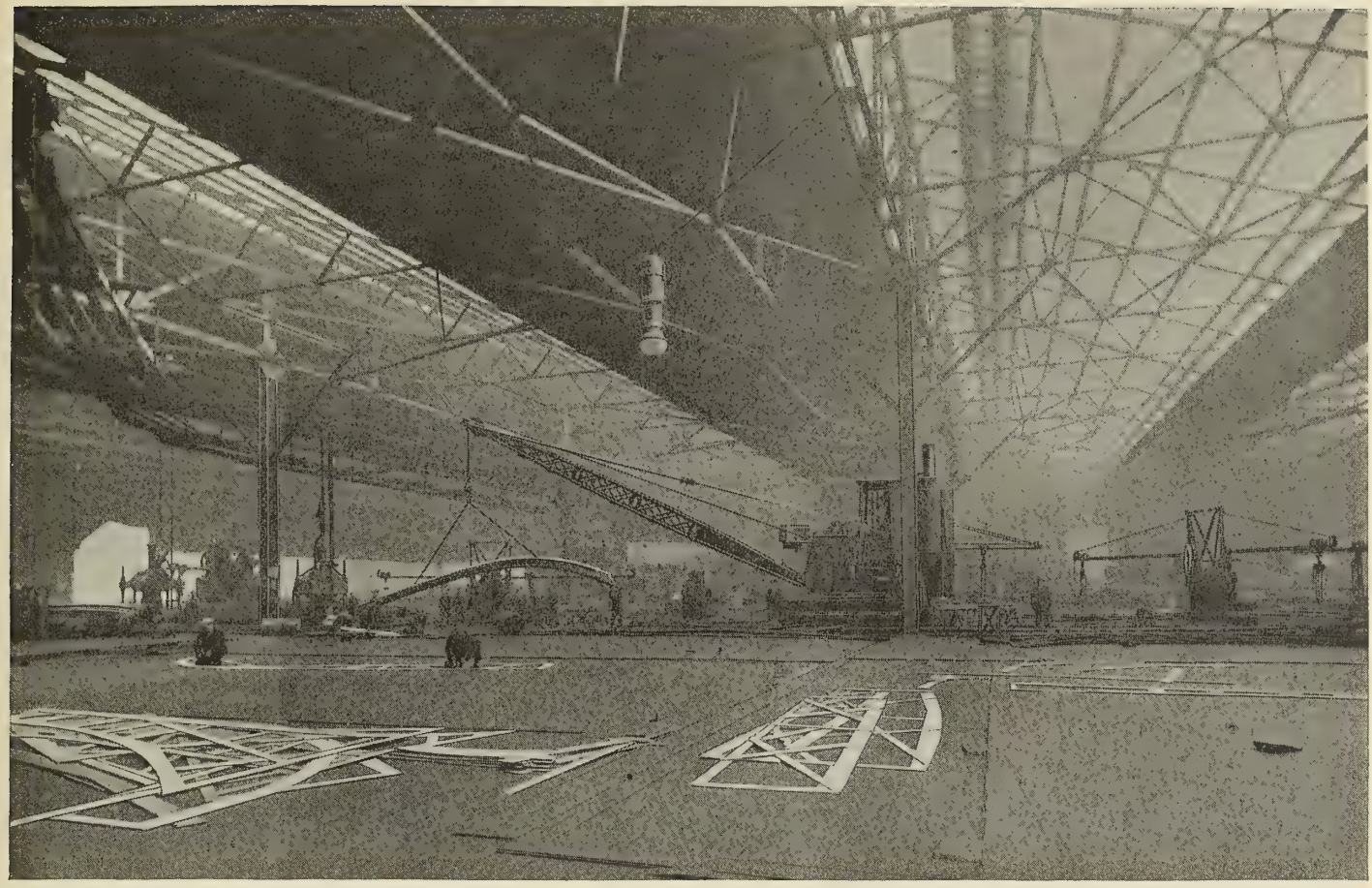


Fig. 15.—Frame Shop, General View Showing Scrieve Boards

phase current at 440 volts and 40 cycles. It is fitted with an electro-magnetic brake and is operated by a horizontal oil-immersed, drum type controller fitted with a hand wheel. The two smaller motors for raising and lowering the upper roller are of the same type but run at 765 revolutions per minute and they are operated by the vertical drum type controllers mounted on a platform on the right hand side of the machine. The three motors are of Messrs. Armstrong's own manufacture.

The hydraulic crane serving this machine was supplied by the engine works department of the firm at Elswick. It is capable of lifting a load of 8 tons a height of 13 feet at a maximum radius of 30 feet and a minimum radius of 10 feet. The lifting motion is effected by a hydraulic cylinder and ram with 4 to 1 multipliying gear, and the slewing motion by a pair of cylinders with 2 to 1 multiplying gear. One of the two cylinders with 4 to 1 gear is also employed for racking the load along the jib.

At each end of the shop are sets of high speed radial drills of a special design mounted on a bridge which runs on rails. The plates to be drilled are laid on bearers between the rails and one or more of the drills is traversed along the rails as the work of drilling proceeds.

Frame Shop

Most of the remaining buildings in the yard are situated at the northern end and are arranged with their greatest lengths at right angles to the fitting out dock. The largest and most important of these is a steel framed structure measuring 380 feet long, 300 feet wide and 30 feet high to the eaves, and comprising the frame shop and anglesmiths' shop. The latter runs across the whole width of the building at the eastern end and is itself 80 feet wide, so that the frame shop is actually 300 feet square. Fig. 14 shows the arrangement of the tools, cranes and other appliances in both shops.

Anglesmith Shop

The anglesmiths' shop contains two electrically driven pneumatic power hammers with a coal fired furnace between them; these are mostly used for drawing packings and similar work. There are a number of pot fires and anvils for anglesmiths' work arranged in convenient groups along the center and down one side of the shop. Blast is provided by three electrically driven fans, which are designed to give an air pressure equivalent to a 22-inch column of water and deliver air to the fires through underground ducts. These are arranged so that air can be supplied to any one of the groups of fires independently of the other groups.

At the northern end of the shop is a gas fired plate furnace, 10 feet 6 inches long by 6 feet wide, provided with bending blocks in front. Near this furnace is a hydraulic plate flanging machine having two 60-ton vertical overhead rams and a smaller horizontal ram for squaring up flanges, etc. The width of the gap from the centerline of the vertical rams to the body of the machine is 4 feet, and there is also a 4-foot clearance between the table of the machine and the bottoms of the rams when the latter are at the upper end of their stroke.

An 80-ton hydraulic press for flanging and pressing work is also located near the plate furnace. The large flanging machine is served by a 5-ton hydraulic crane and the crane equipment of the shop also includes another 5-ton hydraulic crane, used for handling heavy work from railway wagons, and a number of 10 hundredweight hand cranes serving the fires. One of these cranes is used in conjunction with an angle bending, cutting and straightening machine which is located as shown on Fig. 14.

A considerable amount of electric and acetylene welding is carried on in this shop and a special bay is partitioned off at the northern end for this purpose, so that the autogenous welding practically forms a department by itself.

Scrieve Boards

A considerable portion of the floor space in the frame shop, 22,000 square feet to be exact, is occupied by the scrieve boards. On these boards the frames are laid out to full size for making the templates from which the set irons, or lines, are laid out on the bending blocks so that the frames may be bent to the correct form. Fig. 14 shows the relative positions of the scrieve boards, furnaces and bending blocks.

Furnaces

For heating the angle bars from which the frames are formed, two double ended bar furnaces, each 90 feet long by 4 feet wide by 3 feet 6 inches deep, are provided, and there are also three plate furnaces, the largest of which will take a plate 36 feet long by 13 feet wide. These furnaces, it should be explained, are mainly employed for heating the plates for the stems and sterns of ships, but they also deal with any other plates which require furnacing. The doors of the large plate furnaces are fitted with hydraulic gear for opening and closing, and electric winches are provided for hauling the plates from these furnaces and the bars from the bar furnaces. All the furnaces are gas fired, gas being supplied by four producers each capable of gasifying 10 hundredweight of coal a day. Steam for the producers is supplied by two vertical boilers.

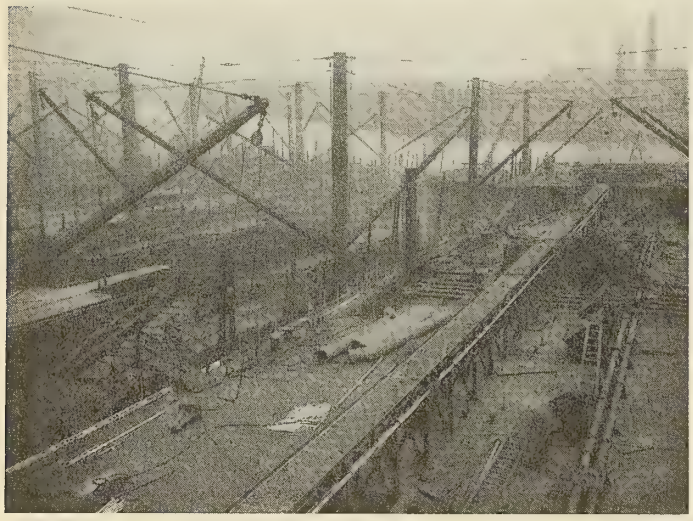


Fig. 16.—View Across Smaller Building Berths

Beveling Machine

A beveling machine is provided at each end of the bar furnaces for opening the angles of the frame bars so that the flanges conform with the line of the shell plating of the ship. These machines, capable of beveling angles up to 10 inches by 5 inches by 1 inch thick, are mounted on rails so that they can be moved into line with either furnace as required. The heated bars, after passing through the beveling machine, are placed on the bending blocks, clamped at one end by iron dogs and bent to the curve of the set iron by means of portable hydraulic frame setters. When cold, the frames are tested against the curves set out on the scrieve board, and, if necessary, returned to the bending blocks for adjustment.

Machine Equipment

The machinery equipment of the shop includes a number of punching and shearing machines, angle cutters, manhole punches, drills, saws, etc., most of which are arranged in the center of the shop as shown on Fig. 14, but two sets of plate bending rolls for forming masts and other tubular work of this class are situated in the southwest corner near the plate furnaces. A portion of the shop alongside the scrieve boards is occupied by a hydraulic riveting plant, the arrangement of which is similar to that at the heads of the building berths. There are also a tool smithy and an electric welding bay in the shop. Two of the plate furnaces are served respectively by 8-ton and 5-ton hydraulic cranes of Messrs. Armstrong's own design and construction and which are similar in every way to those already mentioned when dealing with the platers' shop. Overhead runways of 30 hundredweight capacity are provided for conveying frames between the bending blocks and scrieve boards, but work is also handled by the yard locomotive cranes. The angles required in the frame shop are stored in angle racks on the northern side of the building, the racks being served by a 5-ton electric overhead crane of 120 feet span. A hydraulic angle bar shearing machine and a planing machine for angles are provided in convenient positions near the racks.

Sequence of Work

The general sequence of work through the frame shop is as follows: The bars are taken from the racks and marked off for punching, and after punching and joggling are taken to the furnaces; then, after bending on the bending blocks, they are conveyed to the scrieve boards for trial and, if correct, the ends are faired and the frames delivered onto the berths by rail.

Frame Punching Shop

Additional facilities for frame work are provided in the frame punching shop. This building, which, as shown on Fig. 6, is situated at the southern side of the frame shop, measures 130 feet by 45 feet and is specially arranged for punching and joggling both frames and deck beams. There are three machines in the shop—a double ended duplex punch and two Lambies' patent jogglers. The machines are arranged so that two sets of men can work independently of each other, and this allows four frame furnaces to be kept going continuously. Overhead runways will be used for handling the frames in this shop and also for conveying them to the frame shop in which they will be bent and tried on the scrieve boards as mentioned above.

Deck Beam Shop

At the western end of the frame shop, and in close proximity to the railway tracks on which materials are brought into the yard, is a long, narrow building used for the preparation of deck beams. This building is actually 270 feet long by 35 feet wide. The rolled steel sections from which the beams are formed are unloaded from the railway trucks and passed into the shop at the northern end by means of locomotive cranes. They are then marked off, punched and beveled, or bent, as required, and delivered directly onto the berths from the other end of the shop. The building is equipped with a duplex punching machine and a hydraulic cropper, but the most interesting tool in the shop is the Arthur's patent bending machine.

This machine is capable of admitting beams up to 15 inches in depth and is sufficiently powerful to form the usual deck camber of ¼ inch per foot on bulb angles, bulb tees, channels, zees and other sections up to 13 inches deep. Lighter sections can, if required, be bent to a much smaller radius; for example, bulb angles up to 9 inches deep can be bent cold to a radius of 6 feet, and 6-inch bulb angles can be bent to a 3-foot 6-inch radius.

(*To be continued.*)

An Informational Service Concerned With Metals and Alloys.—An Alloys Research Association is being formed with the aid of the Research Extension Division of the National Research Council, Washington, D. C., with an Alloys Informational Service as the first step. This is to be co-operative on the part of those interested in metals and their alloys.

Fig. 1.—S. S. *Samaria,* Built by Cammell Laird & Company, Ltd., Birkenhead. From an Original by A. J. W. Burgess, R. I.

The New Cunarder Samaria

Transatlantic Passenger Steamer Built by Cammell Laird and Company, Ltd.

THE *Samaria,* launched from the shipbuilding yard of Messrs. Cammell Laird & Company, Ltd., Birkenhead, on November 27, will in her construction and fitting-out represent the latest development of the art of shipbuilding. In both respects she will possess features which set up a new departure in Atlantic travel from the point of view of the comfort and convenience of passengers.

The Old and the New

The launch of the *Samaria* from this famous yard, takes us back to 1882, for the only previous association between the present builders and the company from the point of view of actually building a ship. It was in that year that Messrs. Laird Brothers built the *Cephalonia,* an iron screw steamer which proved such a successful unit of the company's Boston service. The *Cephalonia* had a length of 440 feet 6 inches, breadth of 46 feet 3 inches and a depth of 36 feet. Her gross tonnage totalled 5,517, and her compound engines developed 4,000 indicated horsepower and a sea speed of 13 knots. These dimensions, together with the figures of the old *Samaria,* built in 1868 (length 311 feet, beam 39 feet, depth 28 feet 3 inches, 2,574 gross tonnage, horsepower 1,590 and speed 11 knots) make an interesting comparison with those of the ship under review and reveal something of the progress made during the last fifty years in ship construction.

Principal Dimensions of New *Samaria*

Length overall	623 feet 9 inches
Length between perpendiculars	600 feet
Breadth molded	73 feet 6 inches
Depth molded to shelter deck	45 feet
Gross tonnage	21,000
Sea speed	16 knots

Accommodation for nearly 2,600 passengers, made up of 336 first class, 340 second class and 1,504 third class.

New Features

In the matter of passenger accommodation the *Samaria* will include features which hitherto have not been introduced in a vessel of her size. Garden lounges for the sole use of saloon passengers and a verandah café for second-class passengers set up a high level of luxury which will appeal to the Atlantic traveler.

The various public rooms have been so designed that they all lead from the main staircase, which forms itself into an imposing central hall. The great oval lounge, with its delicate Chinese designs, will, undoubtedly, prove a favorite resort of the *Samaria's* saloon passengers. The drawing and writing room also will maintain the high standard of cosiness attained in the *Samaria's* design. These public rooms will have small subsidiary rooms or alcoves which, while forming part of the general *ensemble,* will maintain a certain sense of privacy. A feature of the dining saloon will be the separate tables for two and four persons or small parties. This is applicable both to first-class and second-class passengers. In the *Samaria,* too, it will be found that a successful effort has been made to provide third-class passengers with every degree of comfort. For all classes of passengers the construction and design of the *Samaria* ensure considerable space, both open and covered, for promenading, exercise and various games.

Passenger Accommodation

The public rooms will include:

Saloon—
- Dining Room.
- Lounge.
- Smoking Room.
- Drawing and Writing Room.
- Garden Lounges.

Second Class—
- Dining Room.
- Drawing Room.
- Smoking Room.
- Verandah Café.

Third Class—
- Dining Rooms.
- General Room.
- Smoking Room.

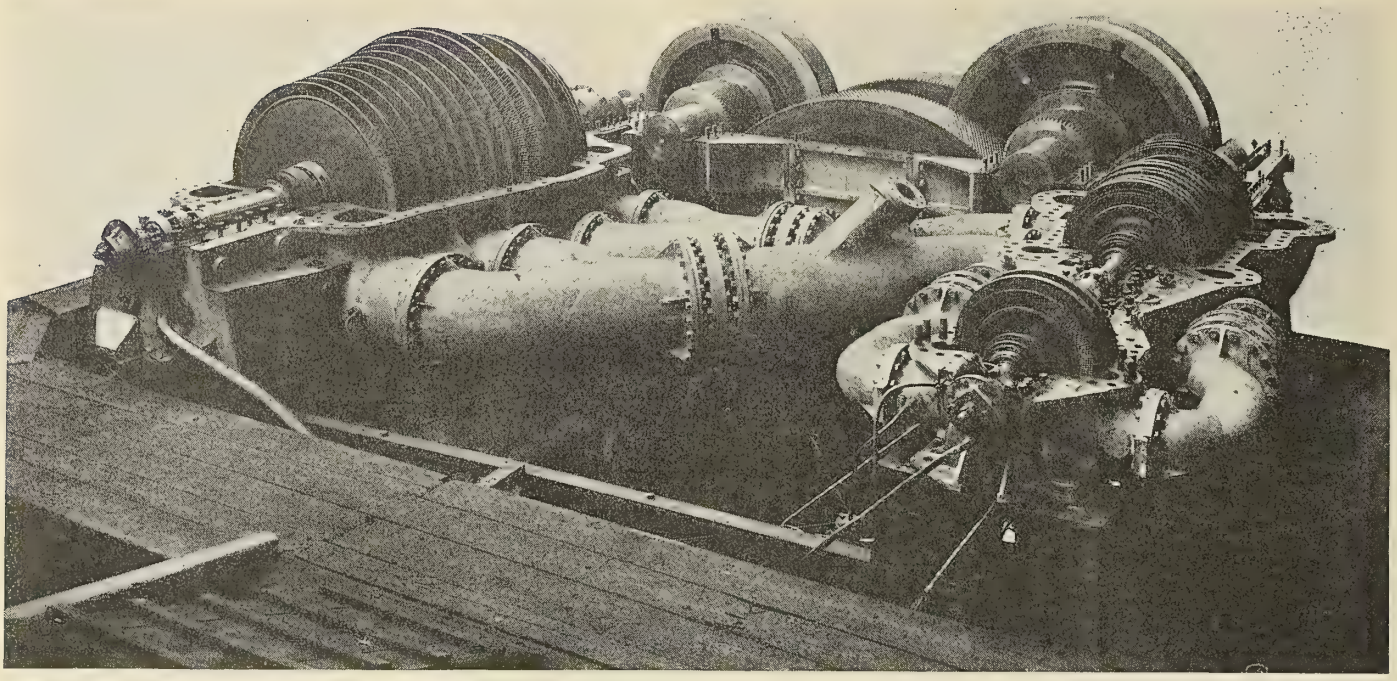


Fig. 2.—Turbines and Reduction Gearing, Upper Casing Removed

The extensive passenger accommodation of the *Samaria* will extend over seven decks. The refinement with which the scheme of decoration is to be carried out to the smallest detail is in keeping with that high standard which has caused Cunard liners to be regarded as models of artistic taste. In a word, the interior of the *Samaria* will be that of a new Cunard floating hotel, and her exterior that of a staunch and steady ocean liner—a worthy successor to a long line of vessels whose names have been world-famous.

Turbines

Each of the two sets consists of one high pressure and one intermediate pressure turbine driving in tandem one pinion and one low pressure turbine driving the other pinion of the first reduction gearing and then through the second reduction gearing to the main shaft. Compound astern turbines are incorporated in the exhaust casings of the intermediate and low pressure ahead turbines. The high pressure turbines are supplied with superheated steam and the low pressure turbine exhausts to the main condensers, which are suspended directly below the turbines and are designed for a high vacuum. The turbine must, of course, revolve at a comparatively high speed in order to operate most economically, while the rate of revolution of the propeller should be considerably less. This result is achieved by the double-reduction gearing.

Oil Fuel

The *Samaria,* too, is the largest liner to be designed and built on the Mersey for the burning of oil fuel. Not only does a certain weight of oil have a greater heating value than a

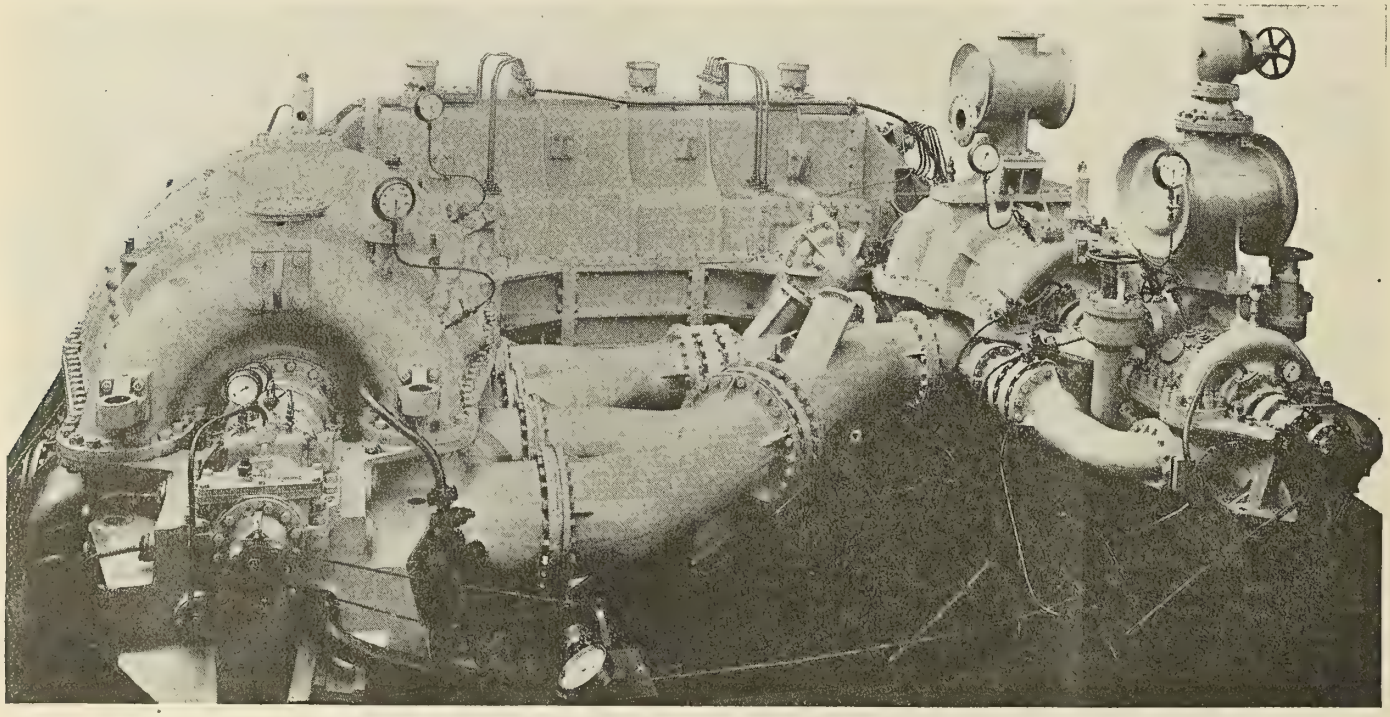


Fig. 3.—Turbines and Reduction Gearing Assembled

similar weight of coal, but it occupies less space and requires infinitely less attention. In addition, bunkering can be accomplished more simply and rapidly, the wear and tear on the boilers is less, and as the oil fuel can be carried in the ship's double bottom, unusually spacious passenger accommodation and cargo holds are available.

Propeller Revolutions

In the case of the *Samaria* the propeller revolutions at full power will be about 90 per minute, corresponding to a speed of 2,750 revolutions per minute for the high and intermediate pressure turbines and 1,770 revolutions per minute for the low pressure turbines. They will develop 13,500 shaft horsepower, the two shafts driving the ship at 16 knots.

Electro-Hydraulic Auxiliary Machinery

The auxiliary machinery of the *Samaria* provides yet another example of the very modern improvements and features which will be found in her construction. The arrangements for the rapid and efficient handling of cargo are of a very complete nature. Numerous steel derricks and cargo spaces are placed at each hatch and electro-hydraulic variable speed gear winches are fitted throughout. The boat winches, capstan, windlass, warping winches and steering gear are all operated on the electro-hydraulic principle. There is thus a complete absence of big steam pipes running fore and aft in the ship interfering with promenade and accommodation space.

Two large sets of turbo-driven generators are to be installed to supply power to the electrical appliances of the ship and an oil driven emergency dynamo is installed on "B" deck.

Gyroscopic Compasses

A wireless equipment of great power is installed. Gyroscopic compasses are provided for navigating the ship as well as patent standard compasses. The gyro is a remarkable invention. While the master compass is fixed on one of the decks below, there will be three separate controlled compasses on the bridge. Its great advantage is that unlike other compasses it is independent of magnetic north and requires no adjustment.

Lifeboat accommodation for all persons on board is provided and Welin's patent quadrant davits are fitted, together with electro-hydraulic boat winches, for the rapid handling of the boats.

Other Appliances

The *Samaria* will pass the survey of the British Board of Trade and American authorities in all respects as a passenger steamer, and the watertight subdivision of her hull and details of her construction and equipment are in accordance with the International Convention Regulations for safety of life at sea. The doors in the bulkheads are operated by hand gearing of the Stone Lloyd hydraulic system, and above the bulkhead deck screen bulkheads are fitted to prevent the spread of fire.

The system of forced lubrication installed ensures a thorough supply of oil to the mechanical gearing and bearings and has been devised to meet the most modern requirements. The main thrust blocks which are of the Michell type are also supplied with forced lubrication.

The propellers have cast steel bosses with separate blades of manganese bronze. All the steel forgings for the turbine rotors, gearing and line shafting have been supplied by the Sheffield works of Messrs. Cammell Laird and Company, Ltd.

There are three double ended and three single ended cylindrical marine type boilers supplying steam at a pressure of 220 pounds per square inch, and fitted for burning oil fuel on the Howden-Wallsend system. The double ended boilers each have eight furnaces and the single ended boilers four; Schmidt's smoke tube type of superheaters are fitted. The installation is supplied with high class auxiliary machinery, including Messrs. Weir's latest closed feed system for dealing with the feed water, turbo-driven main feed pump and turbo-driven main circulating pumps. A number of motor driven pumps for general purposes are also fitted.

The New Shipbuilding Programme

The Cunard Line suffered heavy losses through the nefarious German submarine warfare. Not less than fifteen vessels of the Cunard fleet were lost, equal to 56 percent of the total tonnage. No time has been lost by the company in repairing this deficit, and today thirteen new ships, representing nearly a quarter of a million tons, are under construction. They all represent in their design, both structural and fitting out, the very latest improvements of naval architecture. They are all to be built to burn oil fuel.

Two of these steamers will be in commission in January and February respectively. The *Albania* (12,000 tons), which will carry cabin passengers only, after making her maiden voyage in the Liverpool-Canada-New York service, will return direct to London and take her place in this popular Cunard passenger service from the Metropolis to Canada and New York. The other ship, the *Scythia* (21,000 tons), a sister ship of the *Samaria,* will take her place in the Cunard Liverpool-Canada-New York service, calling at Queenstown.

The *Tyrrhenia* (16,000 tons) is expected to take her place in the company's passenger service early next summer. The remaining vessels will take the water in the near future. They are the *Franconia, Laconia* and *Servia* (each 600 feet long); the *Alaunia, Andania, Aurania, Ausonia, Ascania, Antonia,* all of which will be 520 feet in length. These vessels, with two exceptions, take the names of former vessels of the Cunard fleet and include some which distinguished themselves on war service and were lost through enemy action.

Weights of Various Plumbing Fixtures

	Weight
17 by 19-inch enameled lavatory, with two faucets, trap and hanger	72 pounds
5-foot bath tub, with waste	295 pounds
Flat back lipped urinal with fittings	40 pounds
Shower over bath tub, including curtain, curtain ring and shower head, pins and hold-back chain	9 pounds
20 by 24 by 12-inch galvanized or enameled galley sink, with tray	74 pounds
20 by 30 by 12-inch galvanized or enameled galley sink, with tray	94 pounds
¾-inch brass faucets, compression or self-closing	1 pound
Toilet rack	17 pounds
Syphon jet closet bowl with seat and cover floor flange	80 pounds
14-inch grab rod	2½ pounds
20-inch nickel plated towel rack	1 pound
Pressed steel soap dish	7 ounces
Combined sponge and soap holder	1½ pounds
4-foot heaters with valves	46 pounds
Galley pump, 2-inch	17 pounds
Galley pump, 2½-inch	26 pounds
Galley pump, 2-inch	9½ pounds
Galley pump, 2½-inch	15 pounds
Distributing cocks, two way	5 pounds
Paper holders	8 ounces
Shower head, 6-inch	2 pounds
Mirror, 16-inch by 20-inch	9 pounds
Mirror, 18-inch by 24-inch	11 pounds

Passenger and Freight Steamship Aeolus

General Information

Service: New York and South America, passenger and freight.

Builder: F. Schichau, Danzig, Germany. Reconditioned by Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md.

Owner: United States Shipping Board. Allocated to Munson Steamship Company, New York.

Characteristics

Length, overall.....580 feet 10⅞ inches
Length between perpendiculars.....561 feet 5/16 inch
Breadth, molded.....62 feet 4-1/16 inches
Depth, molded.....39 feet 4-7/16 inches
Draft, loaded, summer.....30 feet ½ inch
Draft, light .....
Block coefficient.....0.748
Midship section coefficient.....0.965
Longitudinal coefficient 0.773
Speed, loaded, knots.....15½
Cruising radius, nautical miles.....16,000
Framing .....Transverse
Class ....A1 American Bureau of Shipping

Tonnages

(In tons of 2,240 pounds)

*Weight of Hull .....
**Weight of Propelling Machinery.....
Deadweight Capacity.....11,205
Displacement 22,450

(In tons of 100 cubic feet)

Gross register 12,642.63
Net register 6,992.00

*Weight of Hull includes Hull Proper, Hull Fittings, Equipment, and Outfit.

**Weight of Propelling Machinery includes Engines, Boilers (Wet), Shafting, Propellers, and Machinery Space Auxiliaries.

Canal Ratings

(In tons of 100 cubic feet)

	Gross	Net
Suez		
Panama	15,041.14	9,569.30

Complement

Deck officers.....	5
Deck crew.....	48
Engineer officers.....	5
Engineer crew.....	52
Purser's and steward's department.....	134
Total officers and crew.....	244
First-class passengers.....	194
Second-class passengers.....	176
Third-class passengers.....	104
Fourth-class passengers.....	
Total passengers.....	474
Total complement.....	718

Handling Equipment

	No.	Type	Capacity	Length
Masts	2	Pole		160 feet above L. W. L.
Derrick posts	2			24 feet above deck
Booms	20		3 Tons	

Discharging Capacity....210 tons per hour

Deck Machinery

Steering Gear.....Brown steam tiller with telemotor control.
Windlass (1) .....Clark-Chapman Co.
Capstans (4) .....Clark-Chapman Co.
Winches (14) .....German make

Life Saving Equipment

Lifeboats	No.	Type	Length
	2	Open	20 feet
	1	"	30 "
	*1	"	26 "
	12	Desked	26 "

* Motorboat.

Propelling Machinery

Boilers

Number 7
Type.....5 Dbl. Ended; 2 Single Ended
Length.....Single 10 feet 3 inches
Double 20 feet 6 inches
Width or Diameter.....14 feet 2 inches
Furnaces..3 in each S. E.; 6 in each D. E.
Fuel .....Oil
Draft .....Natural
Total heating surface, square feet.. 25,833
Total grate surface or furnace volume .....697 square feet
Superheat, degrees F .....
Working pressure, pounds per square inch 220
Normal fuel consumption:
Per day, tons.....115.8
Per horsepower hour, pounds....1.20
Normal steam production:
Per hour per pound of fuel..12.95 lbs.
Total per hour .....140,000 lbs.

Engines

Number 2
Type..Quadruple Expansion Reciprocating
Size.....28.05 inches, 41.34 inches, 59.55 inches, 84.27 inches × 53.75 inches.
Horsepower, normal.....9,000 I. H. P.
maximum .....

Propellers

Number 2
Type.....4-bladed, built-up, bronze
Weight.....35,400 pounds each.
Diameter .....17 feet 9 inches
Pitch .....20 feet 3 inches
R. P. M.....81.50
Projected area .....69.12 square feet
Developed area .....80.4 square feet

Auxiliary Machinery

Refrigerating Machinery

2-60 Ton each. Frick CO_2 Compressors
2 Evaporators
2 Condensers
2 Brine Pumps 7½ inches x 10¼ inches x 10 inches.
2 Circulating Pumps
2 Drinking Water Pumps

Machinery Space

Condensers...2 Main; total cooling surface 12,044 square feet; 4834 tubes, ¾ inches dia., 13 feet 4¼ inches long.
Evaporators.....2-40 ton Row & Davis
Distiller.....1-40 ton Row & Davis
Filters....1 Aerating, 30 inches x 30 inches Row and Davis
1 Feed Water, 5 inches—Row & Davis
Feed water heater....1-2 pass Row & Davis
Pumps
2 Main circulating, 48 inches impeller, 18 inches suc., 18 inches disch., engine 8¾ inches x 13¾ inches x 10 inches
2 Main air, plunger type, 24 inches x 25 inches
1 Aux. air, 10 inches x 20 inches x 16 inches, V. S., Worthington
2 Sanitary 6¼ inches x 25 inches
2 Bilge, 6¼ inches x 25 inches
1 Fire, 12 inches x 14 inches x 12 inches, V. D., Worthington
2 Feed, 18½ inches x 13½ inches x 24 inches, V. S., Worthington
1 Fuel Oil Transfer, Epping-Carpenter
4 Fuel Oil Service, Dean
Oil heaters 6-18-inch steel, White

Electric Equipment

Generators..1-100 k.w. Turbo-Gen. Electric
Radio.....2 K. W. Marconi

Holds

No.	Length	Hatches
1	39'0"	10'0" x 11'0"
2	47'6"	15'0" x 16'0"
3	47'6"	22'6" x 16'0"

Capacities

Cargo Space

Compartment	Bales, Cu. Ft.
No. 1 Hold	16,555
No. 2 Hold	33,959
No. 3 Hold	36,444
No. 1 Lower 'Tween Deck	8,470
No. 2 " " "	17,124
No. 3 " " "	18,836
No. 2 Upper " "	17,692
No. 3 " " "	18,936
No. 1 Hatch Trunk	3,220
No. 2 " "	2,558
No. 3 " "	3,856
No. 4 " "	3,871
No. 5 " "	5,542
No. 6 " "	3,978
Total	191,041

Refrigerated Space

Compartment	Cu. Ft.
No. 4 Lower 'Tween Deck	6,090
No. 5 " " "	12,804
No. 6 " " "	12,317
No. 5 Upper " "	14,115
No. 6 " " "	12,918
Total Ref. Cargo Space.....	58,244

Refrigerating Space for Ship's Use

No. 4 Upper 'Tween Deck....	8,783
Total Refrigerated Space....	67,027

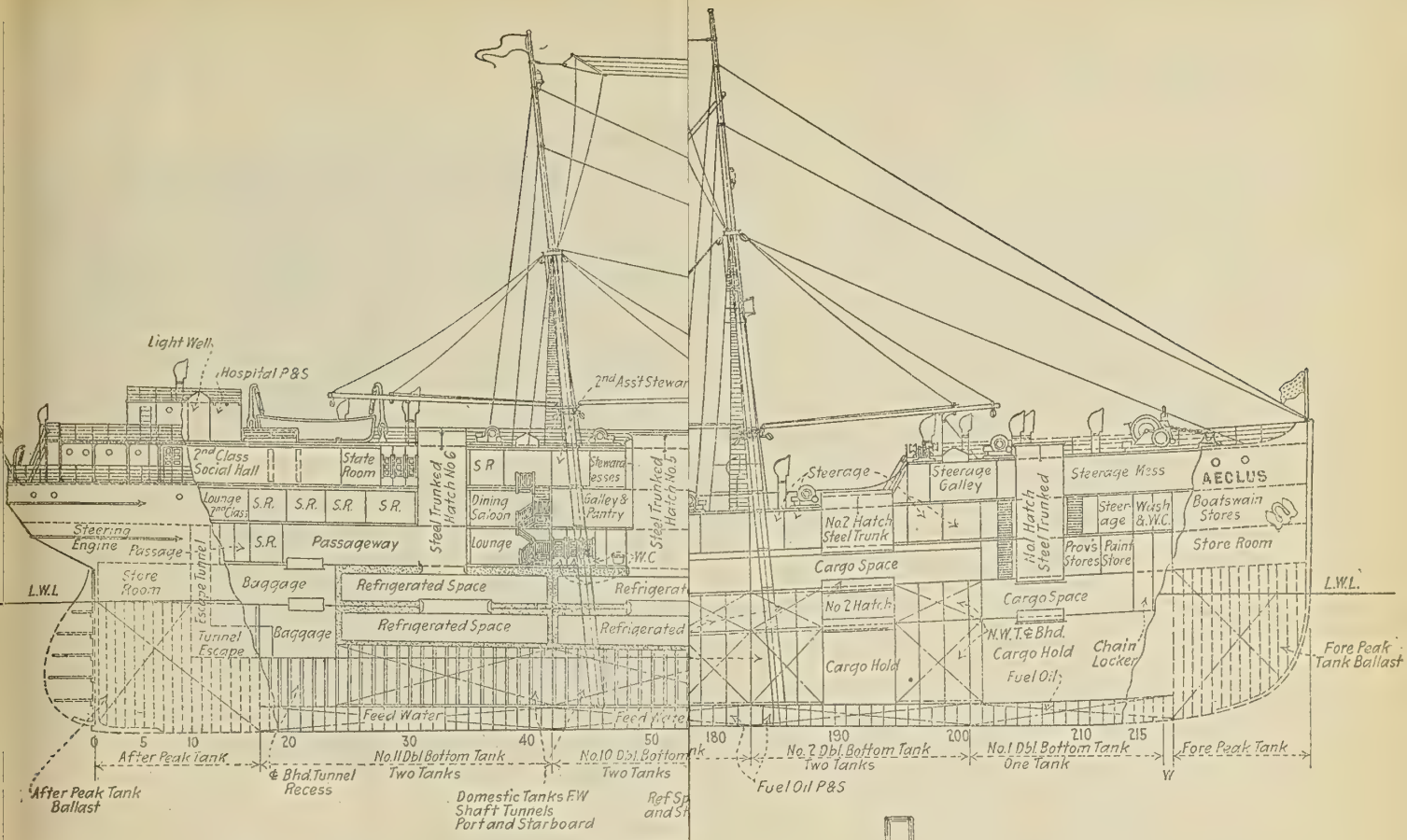
Bunkers

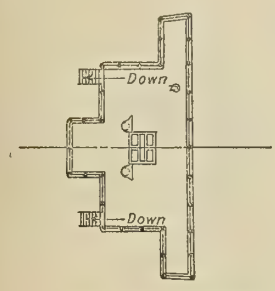
(Compartment)	Cu. Ft.	*Bbls.	*Tons
No. 1 Dbl. Bottom P. & S.	1,650	294	43
No. 2 " " "	4,020	716	104
No. 3 " " "	6,636	1,182	172
No. 4 " " "	9,728	1,732	252
No. 5 " " "	9,898	1,762	258
No. 6 " " "	9,428	1,680	244
No. 1 Deep Tank "	53,810	9,584	1,398
No. 2 " " "	48,377	8,616	1,257
No. 3 " " "	51,390	9,152	1,334
No. 4 Wing " "	8,588	1,530	224
No. 5 Settling Tanks "	14,156	2,522	368
No. 6 Wing " "	8,166	1,454	212
Total	225,847	40,224	5,866

*38.5 Cubic Feet per Ton; 42 gallons per barrel

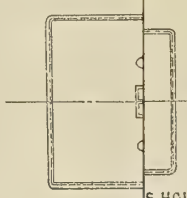
Tanks

(Compartment)	Cu. Ft.	Tons. F. W.	Tons. S. W.
Fore Peak Tank.....	7,239	201	207
No. 7 Dbl. Bottom P. & S.	4,446	124	
No. 8 " " "	3,268	90	
No. 9 " " "	3,554	98	
No. 10 " " "	4,944	138	
No. 11 " " "	3,107	86	
After Peak Tank.....	5,085	141	145
No. 7 Wing Tank P. & S.	6,280	174	
No. 8 " " "	8,156	226	
No. 9 Deep " "	22,436	623	
No. 10 " " "	16,150	449	
Gravity Tanks.....	372	9	
Total	85,037	2,361	352

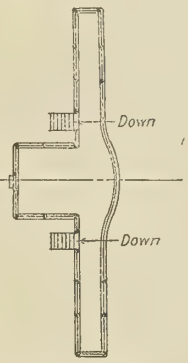




DOCKING BRIDGE

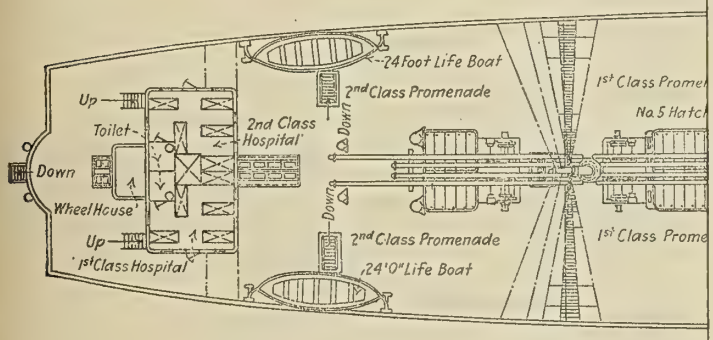


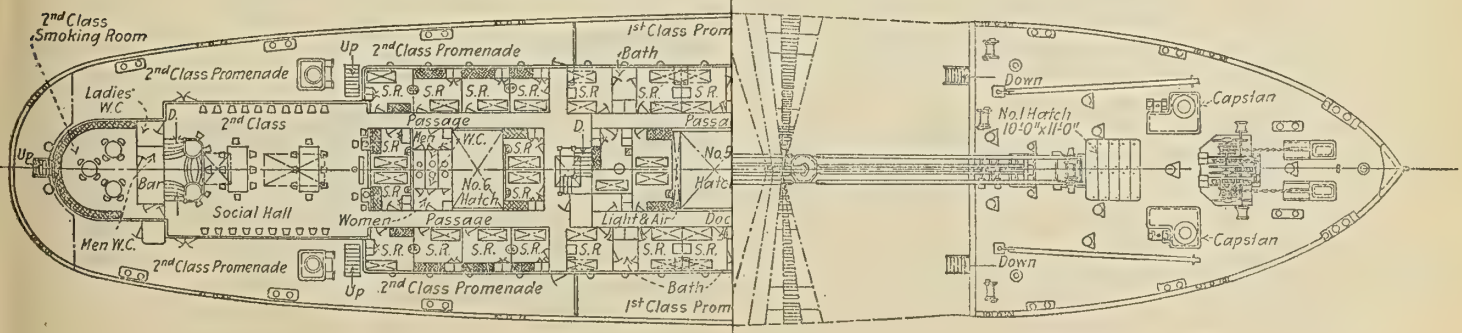
TOP OF GY S HOUSE



FLYING BRIDGE

Height of Eye on flying Bridge about 49'-0 above 30'-0" Water Line





FORECASTLE DECK

STEAMSHIP AEOLUS

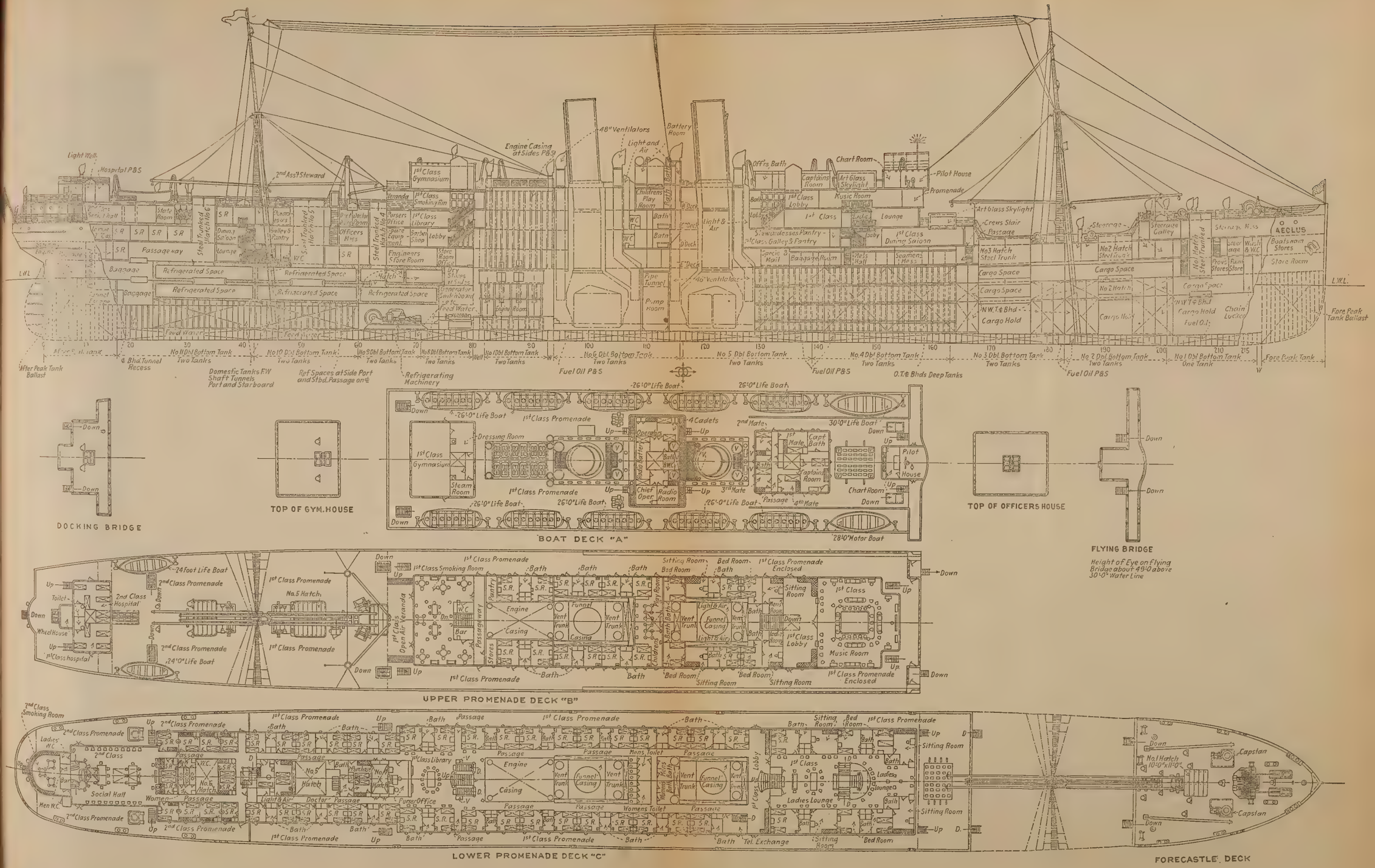
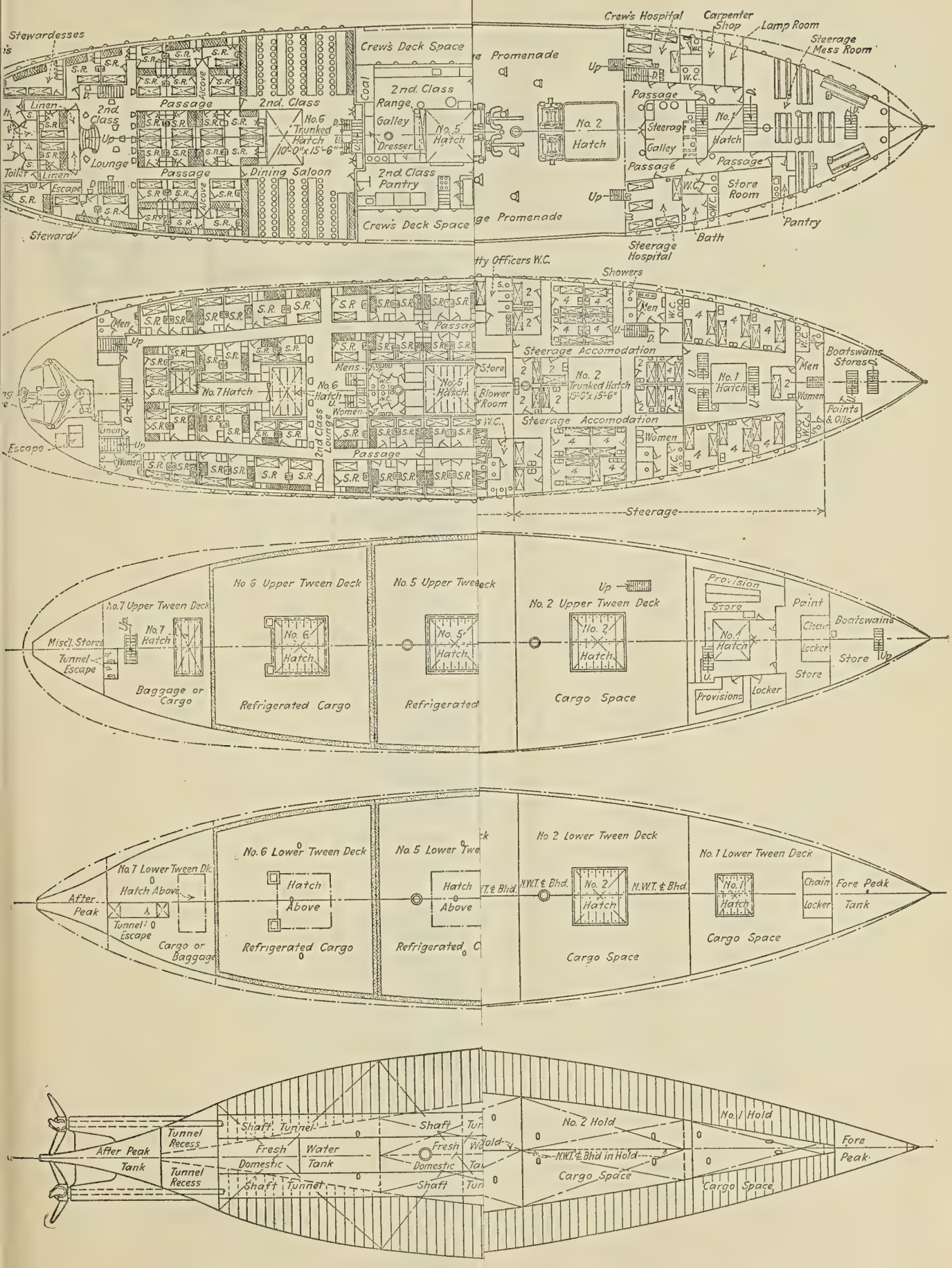


Fig. 1.—Profile and Deck Plans


Stewardesses
Crew's Deck Space
Promenade
Crew's Hospital
Carpenter Shop
Lamp Room
Steerage Mess Room
2nd. Class
Passage
Range
Galley
Dresser
No. 5 Hatch
No. 2 Hatch
No. 1 Hatch
Steerage
Store Room
Pantry
Bath
Steerage Hospital
Dining Saloon
Lounge
Toilet
Linen
Escape
Steward
No. 6 Trunked Hatch 10'-0"x15'-6"
2nd. Class Pantry
Crew's Deck Space
Promenade
Officers W.C.
Showers
Men
Steerage Accomodation
No. 7 Hatch
No. 6 Hatch
No. 5 Hatch
Blower Room
No. 2 Trunked Hatch 15'-0"x15'-6"
No. 1 Hatch
Boatswains Stores
Paints & Oils
Women
Escape
Steerage
No. 7 Upper Tween Deck
No. 6 Upper Tween Deck
No. 5 Upper Tween Deck
No. 2 Upper Tween Deck
Provision Store
Paint
Boatswains Store
Misc'l. Stores
Tunnel Escape
Baggage or Cargo
Refrigerated Cargo
Refrigerated
Cargo Space
Provisions
Locker
No. 7 Lower Tween Dk.
Hatch Above
No. 6 Lower Tween Deck
No. 5 Lower Tween Deck
No. 2 Lower Tween Deck
No. 1 Lower Tween Deck
After Peak
Tunnel Escape
Cargo or Baggage
Refrigerated Cargo
Refrigerated C
N.W.T. & Bhd.
Cargo Space
Chain Locker
Fore Peak Tank
Tunnel Recess
After Peak Tank
Shaft Tunnel
Fresh Water Tank
Domestic
No. 2 Hold
No. 1 Hold
N.W.T. & Bhd in Hold
Cargo Space
Fore Peak

STEAMSHIP AEOLUS

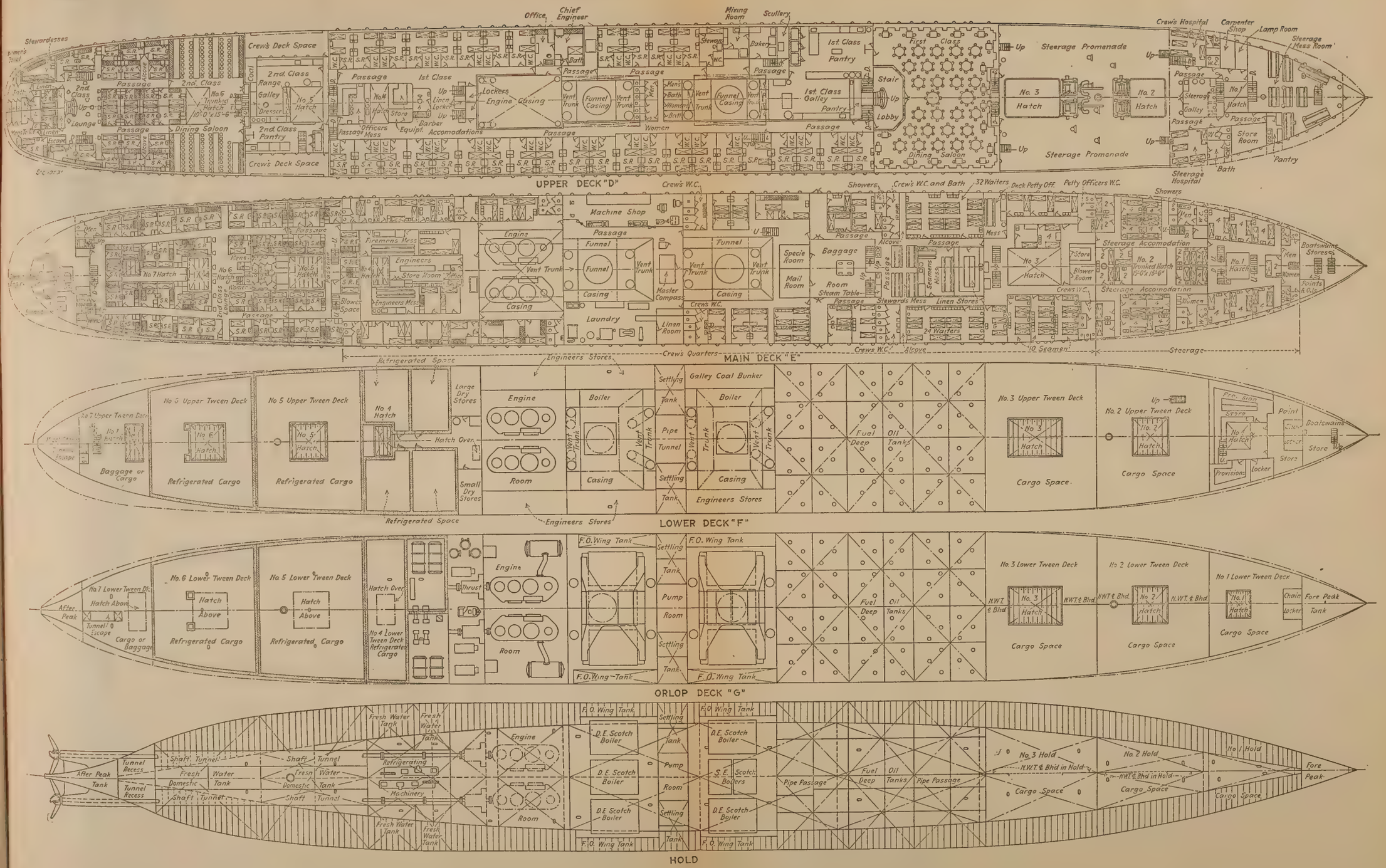


Fig. 2.—Deck Plans

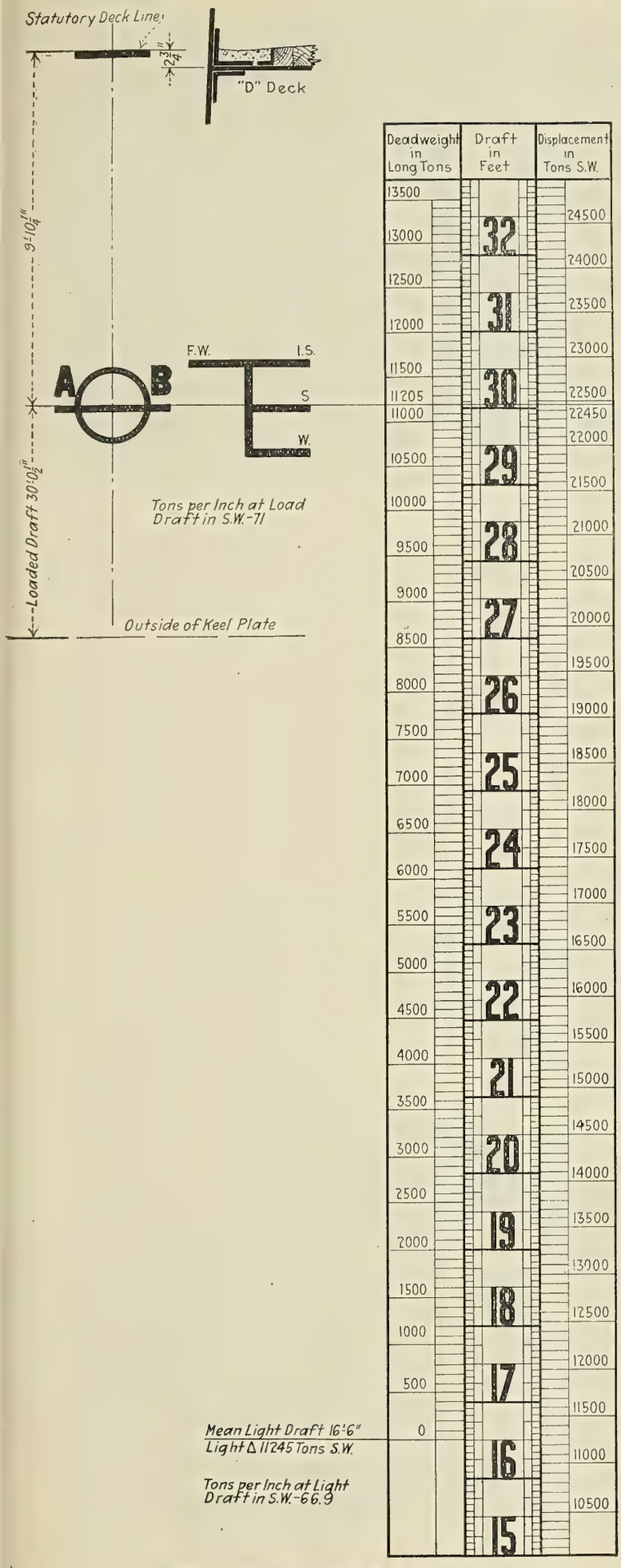


Fig. 3.—Capacity Scale, S. S. *Aeolus*

A Cubist Ship

THE steamship *Newton,* which has recently passed through the hands of the refitting gangs of the Erie Basin plant of the Robins Dry Dock and Repair Company, is one of the new "cubist" boats turned out on a straight line method. This ship is peculiar in that she has vertical sides down to a bilge which is cut off at an angle of about 45 degrees. The bilge plate is carried flat and lapped onto the side and bottom plating.

The upper knuckle which is produced by this method of construction is carried forward into a "chime" or sharp knuckle which is allowed to die away as it approaches the stem. The after end of the bilge is carried along in the same

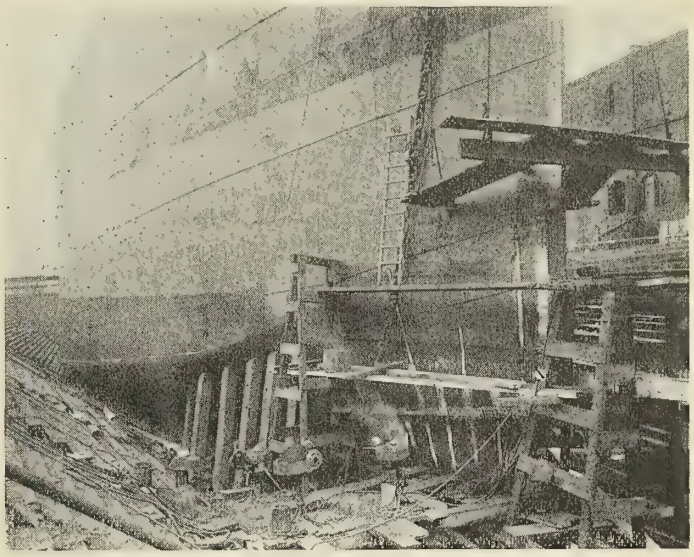


Fig. 1.—The Flat Bilge Plate of the *Newton* Ends Forward in a Chime Which is Carried Well Toward the Stem

manner as forward, only the knuckle fades into the "run" of the ship and appears to be swung in an upward curve to meet the other side of the shell plating, aft of the rudder, in a sharp line.

To add to the odd outlines of the vessel the stern is cut square off at right angles to the centerline. This gives a section resembling a triangle, except that the sides of the ship being slightly "flared" the side of the triangle are not really straight lines.

The bows of the ship are quite shipshape, and above water

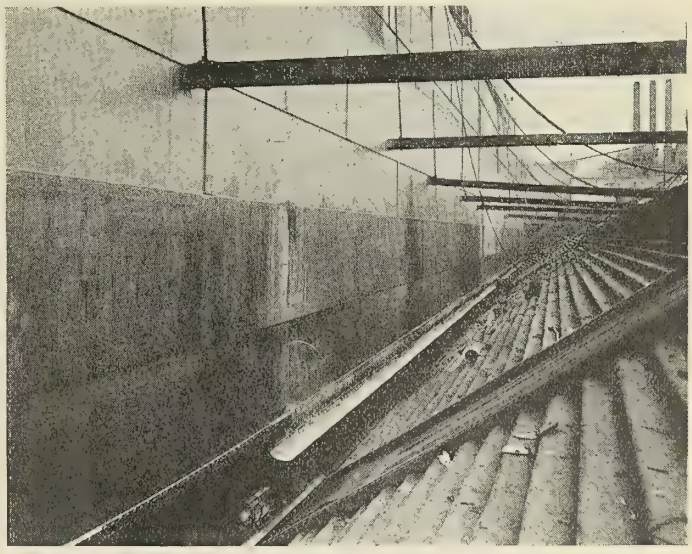


Fig. 2.—Bilge Keels Were Fitted to the Flat Diagonal Bilge Plate of the *Newton* When Undergoing Repairs

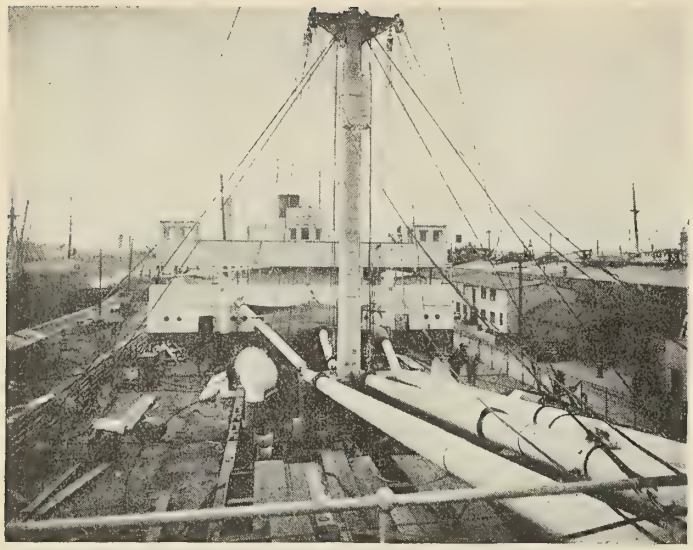


Fig. 3.—Simplified Methods of Fabrication Were Used on the *Newton* to the Fullest Extent. Ventilator Hoods, Lower Masts and Other Fittings Were Made With Square Corners or Knuckles for Ease in Workmanship. Only the Cargo Booms and Topmasts Retained a Round Section

Fig. 5.—To Avoid a Long Delay in Securing a Casting the Blacksmith Shop Obtained a Heavy Ingot and Used a Steam Hammer in Working Out a Dished Plate of the Required Shape for a New Shoe

there is nothing to indicate anything out of the ordinary in the construction of the boat. The flat bilge strake of plating is secured at the butts by outside straps. Masts and other deck erections are also square in section and the same idea of ease in fabricating the material is held in the deck houses and other deck fittings.

The *Newton* has been overhauled, as considerable of her shell plating was in need of fairing and renewing. A great many plates were either faired in place, removed and faired, or else entirely replaced with new plates.

The yard workmen have one specially good job to their credit on this work. A portion of the lower end of the stem had to be replaced, and as a new casting would require considerable time for a new pattern, casting, machine shop work, etc., the blacksmiths were called upon to see what they could do. The result was they secured a large ingot, worked it into the shape required and the whole job was ready for the work of installing in place within a very short time.

The rudder plate was faired and all sea connections overhauled while the ship was in dry dock. Some deck damage was repaired, as the rail and stanchions on the port quarter were broken. Two of the lifeboats were sent ashore for renewals of some broken planks. The tail shaft was drawn while in dock and the old propeller was unshipped, sent on deck and the spare one shipped in its place.

All ballast and peak tanks were tested for watertightness and any loose rivets found in the hull plating were removed and new ones driven.

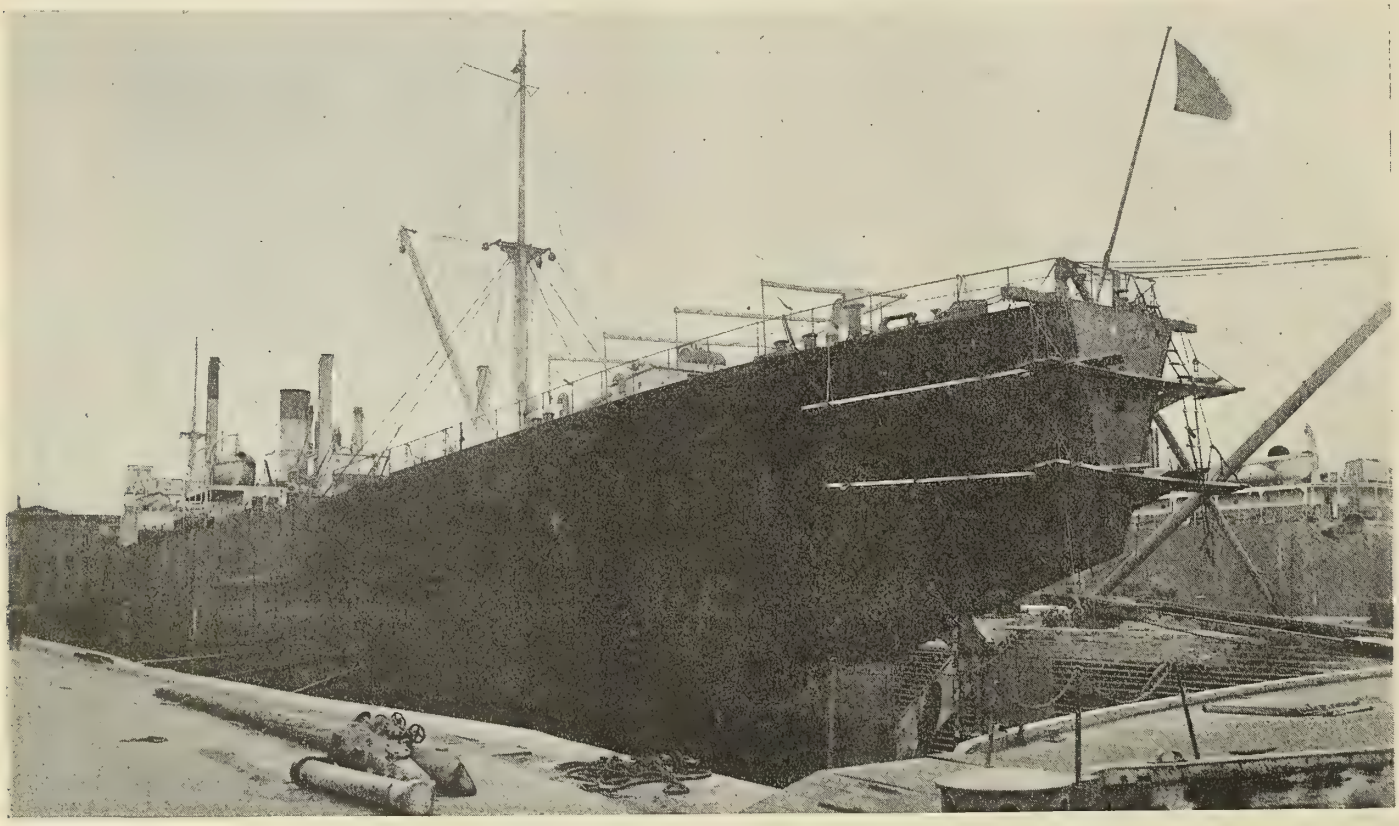


Fig. 4.—The Peculiar Style of Framing of the *Newton* is Shown by This View of the Stern, the upper Knuckle of the Bilge Being Carried In to the Run and Meeting the Other Side Plating on the Centerline of the Ship

Fig. 1.—Sketch of United States Scout Cruisers Nos. 4 to 13, Inclusive

New Scout Cruisers of Immense Engine Power

The new United States light cruisers now under construction will be the most effective scouting vessels ever built by any nation. They will be swift enough to outrun anything afloat. large enough to keep their speed in heavy seas, roomy enough to rush detachments of marines to "trouble spots," and powerful enough to overwhelm destroyers and other light craft.

WITH a length of 550 feet, a beam of 55 feet, a displacement of 7,100 tons, a maximum speed of 35 knots, and a complement of 330 officers and men, the new scout cruisers for the United States Navy carry twelve of the new 53-caliber 6-inch guns, mounted in turrets located forward and aft, and also have torpedo tubes and anti-aircraft guns. Light but efficient vertical and horizontal armor protects the machinery spaces. A new feature, never before incorporated in any ship of the powerful military type, is the complete equipment on each ship for launching and operating four hydro aeroplanes.

Ten vessels of this class are called for on the present programme, and of these, three—the *Omaha, Milwaukee* and *Cincinnati*—are near completion at the yards of the Todd Dry Dock and Construction Company, Tacoma, Wash., and will be commissioned in the near future.

The Propelling Machinery

Interesting as these vessels are as naval units, they are perhaps even more so from the standpoint of steam engineering, since each is to be driven by geared turbines having a total capacity of 90,000 horsepower. Never before has so large an amount of power been installed in so small a space.

Each ship has four 22,500-horsepower cross-compound Westinghouse turbines, and each turibne is geared to a propeller. The turbines for the two center propellers are placed together in an engine room located well aft, and the turbines for the wing propellers are placed in a second engine room farther forward, with the boiler rooms between the two engine rooms.

Each turbine consists of a high pressure and a low pressure element which drive the propeller through a common gear. The high pressure element consists of two rows of impulse

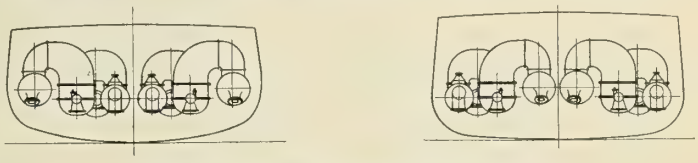


Fig. 3.—Sections Through Engine Rooms

blading followed by reaction blading. A special belt of this reaction blading is used only when running at low speeds and is by-passed for operation at higher speeds. The low pressure element, which normally receives steam from the high pressure element and discharges it into the condenser, has reaction blading only. Both elements are rated at 11,250 horsepower each, and either can be used independently in case the other is out of service for any reason.

An astern turbine, consisting of two rows of impulse blading, is incorporated in each low pressure element. When supplied with the same amount of steam as for full ahead

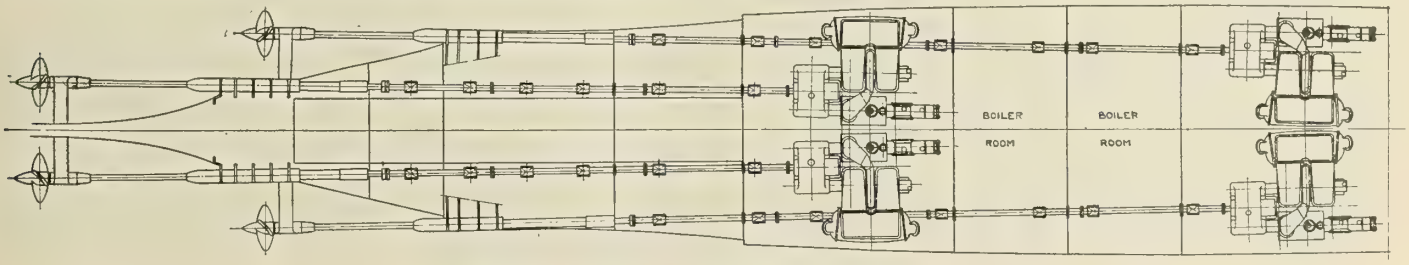


Fig. 2.—Arrangement of Propelling Machinery

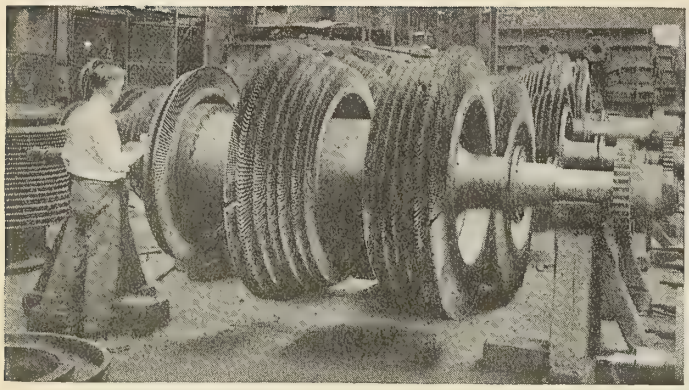


Fig. 4.—Low Pressure Rotors

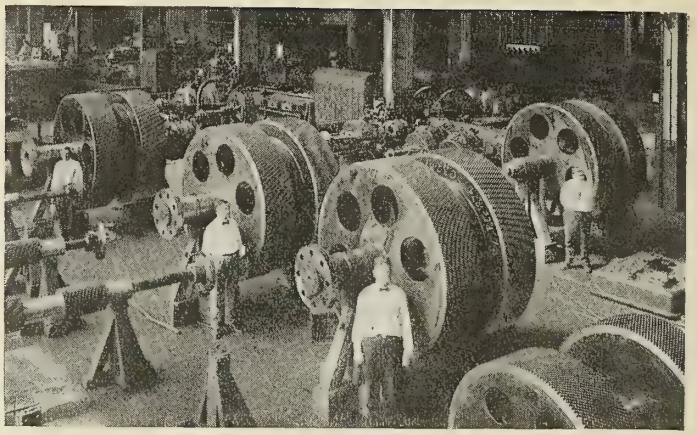


Fig. 5.—Gear Wheels

operation, the astern turbines can develop 30 percent of the full ahead power and can drive the ship at about 20 knots.

Main Gears

The reduction gears are of the Westinghouse floating frame type. Each has two pinions, one for the high pressure and one for the low pressure rotors, and a single gear wheel connected to the propeller shaft. The speed reduction ratio is about 7 to 1 and is effected in a single step.

The Cruising Turbines

The main turbines can propel the ship at speeds ranging from 12 to 35 knots, but as only a relatively small amount of power is needed for low speeds, small auxiliary turbines are used for cruising purposes. There are four of these cruising turbines per ship and each consists of a single row impulse wheel and can develop 420 shaft horsepower at 6,000 revolutions per minute. Each cruising turbine is mounted on an extension of the case of a main high pressure element and can be coupled to the high pressure rotor through a gear giving a speed reduction of about 6 to 1. The mechanical line-up is, therefore: Cruising turbine, cruising gear, coupling, main

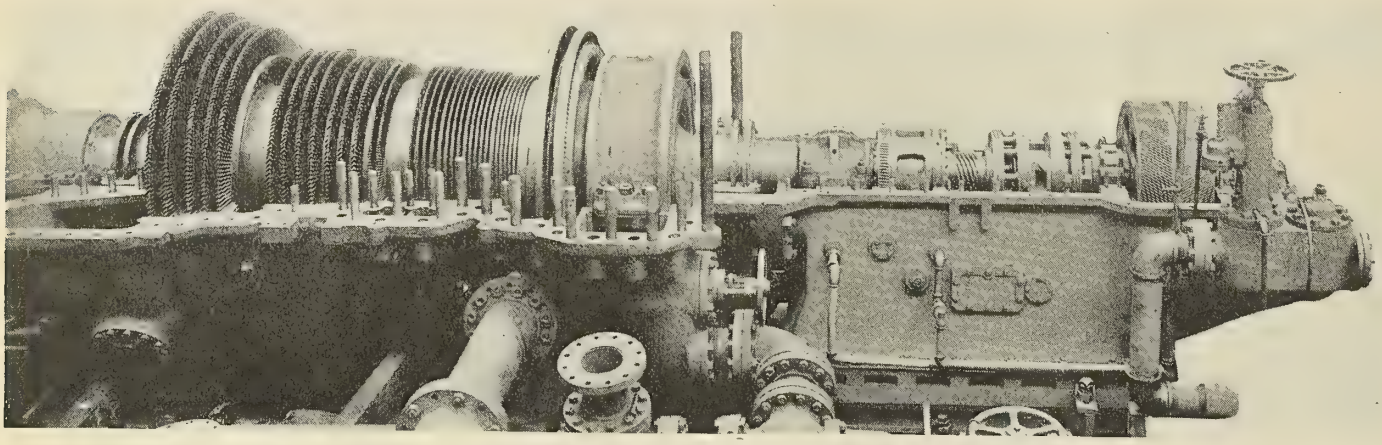


Fig. 6.—High Pressure and Cruising Turbines With Covers Removed

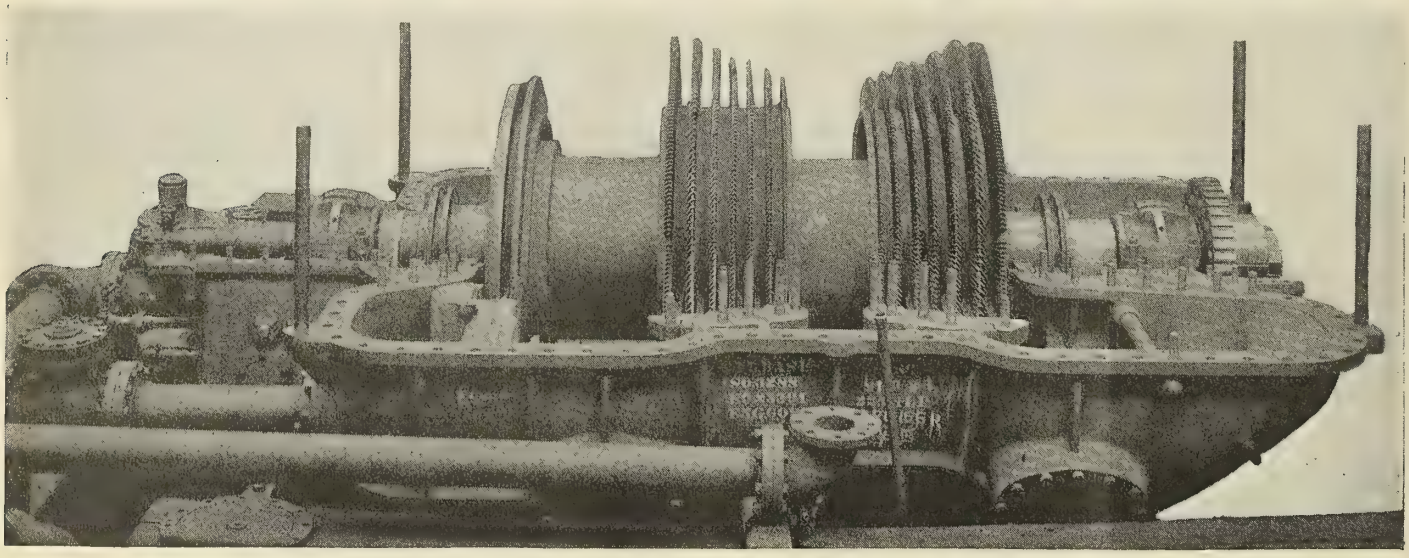


Fig. 7.—Low Pressure Turbine With Covers Removed

high pressure rotor, main low pressure rotor, main gear, propeller shaft.

The steam first passes through the impulse blades of the cruising turbine, then through the reaction blades of the cruising belt of the main high pressure element, then through the remaining reaction blading of both elements, and finally into the condenser. With this arrangement a maximum of 1,000 horsepower can be obtained from each of the four turbines. The cruising speeds range from 12 to 15 knots, with excellent steam economy over the entire range.

The coupling that connects the cruising turbine with the rotor of the main turbine is operated by means of a hand lever. To connect a cruising turbine when the main turbine is in operation, the former is brought up to speed and the latter slowed down, until a synchronizing device indicates that the two are operating at the same speed, when the connection can be made with safety.

Special care is taken to prevent the cruising turbines from overspeeding either when operating under their own power or when accidentally left connected to the main turbines and driven by them. A flyball governor controls the throttle to each cruising turbine and also, through a relay, the governor valve of the main turbine. If the cruising turbine operates at 10 percent overspeed, this governor cuts off the steam to both turbines. If this governor should fail to operate at 12 percent overspeed, an emergency stop cuts off the steam to the cruising turbine and disconnects the coupling.

Auxiliaries

Westinghouse air ejectors and air separators are used to maintain vacua of over 29 inches specified for these turbines. The condensate is handled by four Westinghouse turbine-driven centrifugal pumps, each with a maximum capacity of 500,000 pounds of condensate per hour at a head of 65 feet.

National Foreign Trade Council

REALIZING probably more keenly than ever before the imperative necessity of a permanent foreign trade as a stabilizer of American production, the country's exporters will doubtless attend in exceptional numbers the eighth annual convention of the National Foreign Trade Council, scheduled for Cleveland next May. The efforts of the convention will be directed toward securing more definite and aggressive co-ordination of the varied foreign trade activities and to reinforce them with the decisive co-operation of the various governmental agencies. Incidentally, it is non-partisan and non-political.

The annual conventions are much in the nature of an annual review of the Council's activities in investigating and advising on all phases and movements of national importance that make for an increased volume in the nation's export business. They are really concentrated training schools in foreign trade relations and conditions wherein the attendance is treated to the experiences and best advice of the men who stand highest in the export field, who know its every angle and are qualified best to speak with authority. They assemble the best and most enterprising business brains of the country.

American industrial production during the last ten years has experienced a wonderful and unprecedented growth. Stimulated during the war period by an exceptional foreign demand, manufacturing plants generally increased their producing capacity far beyond their normal requirements. In many instances today their purely domestic trade falls short of consuming their output, with the result that America is more than ever facing a situation where it is imperative that we become a nation of world traders, if our industries are to continue in active operation and our prosperity as a nation is to endure. It is a radical departure from former conditions.

In the old days the American manufacturer, generally speaking, was content with his domestic trade. He looked to the foreign markets only in periods of overproduction or depression at home. Under those conditions he shipped his surplus stock abroad with selling instructions and made the best of a bargain that usually was unsatisfactory. His interest in foreign trade naturally was not overly keen. He made no effort to extend his foreign acquaintance and connections. For years our exports, chiefly promoted by the larger industrial interests, averaged but a trifle in excess of 7 percent of our production.

Under the stimulus of a war-made foreign demand American exports increased from less than two and one-half billions in 1913 to more than eight billions in 1920. The remarkable period of prosperity that attended this revolutionary condition fully awoke the American manufacturer to the tremendous possibilities of a well-developed and permanent foreign trade. But out of it all grew no really definite and lasting foreign connections for the great majority of those who profited chiefly from munition making. It is this class of manufacturer who should be most keenly interested in the problems that will come up for discussion before the next National Foreign Trade Council convention.

Necessity for Foreign Trade

In his address before the recent annual meeting of the Council in New York, James A. Farrell, chairman, particularly stressed the need of a permanent foreign trade. "In practically every business," he said, "there is a part of the production, roughly estimated as the last 20 percent, which cannot remain unsold if the first 80 percent of the sales are to prove profitable. Remove this last 20 percent and the whole operation ceases to show a profit. So it is with the productive capacity of the United States: a certain volume of foreign sales must be maintained or the industry of the country will suffer throughout."

Mr. Farrell declared further that the recent industrial slowing up might have been avoided "had our producers shown more desire to add the demands of an understocked world to those of the local markets of the United States." He held it imperative to the continued prosperity of America that every manufacturer engage in export business and allocate some definite portion of his output to foreign trade. That the convention will resolve for more active governmental co-operation was foreshadowed in his statement that "other nations, older in the field, control cables, coaling stations, harbor and terminal privileges, banking facilities and railroad and shipping systems. It is doubtful whether private American enterprise can at this late date obtain similar facilities unaided."

With the industrial interests of Europe rapidly becoming rehabilitated and our exports on the decline, it behooves American industry to make speedy and exceptional effort to keep alive the friendly relationships formed when the world's markets were open to our products. A dependable foreign trade will provide a highly beneficial vehicle for carrying any line of manufacturing over periods of dullness at home, permit increased output and insure the plant constant operation, while enabling a lowering of overhead charges and making possible the manufacture of goods at a lower price through increased production. These are problems certain to come before the Cleveland convention for exhaustive discussion.

The Cleveland convention committee of fifty is officered as follows: Samuel Mather, Pickands, Mather & Company, honorary chairman; E. R. Fancher, governor of the Federal Reserve Bank; Myron T. Herrick, prresident the Society for Savings; Henry Howard, the Grasselli Chemical Company; William P. Palmer, president the American Steel & Wire Company; and Ambrose Swasey, president the Warner-Swasey Company, honorary vice-chairman; and H. F. Seymour, the Columbian Hardware Company, executive chairman.

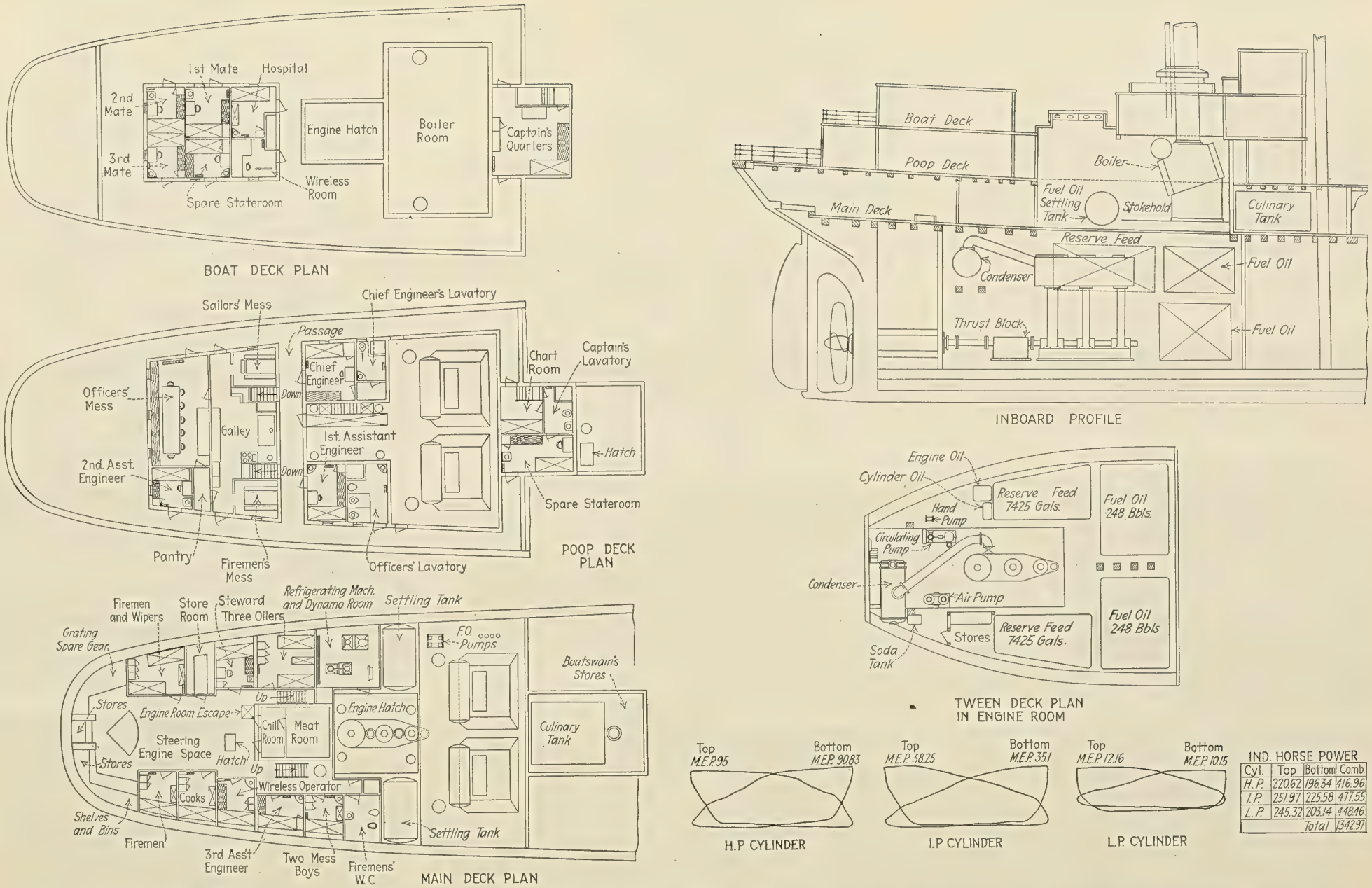


Fig. 1.—General Arrangement Plans in Way of Machinery Space of Ferris Type Wooden Vessel After Conversion Into Lumber Carrier. Indicator Cards from Main Engine

21265

Ferris Type Wooden Hull Proves Efficient Lumber Carrier

BY JOHN J. MUIR*

IN the early part of this year Albert Schubach, of Seattle, Wash., in conjunction with other Seattle capitalists, purchased a Ferris type wooden hull from the United States Shipping Board Emergency Fleet Corporation. It was decided to equip the vessel in the most suitable and up-to-date manner as an efficient lumber carrier. This work was put in the hands of the Grays Harbor Motor Ship Corporation, Grays Harbor, Wash., under the supervision of Captain W. A. Magee, formerly district manager for the Seattle district of the Emergency Fleet Corporation for the hull and equipment, while the installation of machinery and boilers was under the direction of William Macdonald, formerly senior performance engineer for the Seattle district of the Emergency Fleet Corporation.

This article is only intended to cover the installation of the machinery and boilers and the arrangement of quarters aft, as this type of hull has already been described in this magazine. There is therefore no need of giving a detailed description of its construction here. Suffice to say that the hull was built by the Grant-Smith Porter Company at their yard in Aberdeen, Wash., and the high class quality of the hulls turned out by this concern is sufficient guarantee that the construction of the hull of the *Forrest King* is first class in every respect, both as regards workmanship and material.

Principal Dimensions

The dimensions of the vessel, which has been given the highest class at Lloyds for wooden vessels, are as follows:

Length on load waterline	267.6 feet
Breadth	46.2 feet
Depth of hold	24 feet
Deadweight capacity on 23-foot draft	3,500 tons
Gross registered tonnage	2,426.45
Net registered tonnage	1,724

New Arrangement

The Ferris type hulls were originally designed for the engines and boilers to be placed amidships, but in the *Forrest King* the propelling machinery is placed as far aft as possible, an arrangement which permits of the stowage of the largest possible cargo of lumber both in the holds and on deck. Fig. 1 shows the new arrangement of machinery spaces and quarters aft and also a typical set of indicator cards.

The engine and boiler room crews' quarters are all located aft on the main deck, and the navigating officers' quarters are located aft on the boat deck. Seamen's quarters, as well as the lamp room and paint and oil rooms, are located in the topgallant forecastle.

The compactness and accessibility of the quarters is noteworthy, particularly the handiness of the galley to the mess rooms and officers' dining room.

Main Propelling Machinery

The main engines, made by the Nordberg Manufacturing Company, of Milwaukee, Wis., are standard Shipping Board design, vertical triple expansion, with cylinders 19 inches, 32 inches and 56 inches diameter by 36 inches stroke. As already stated, they have been placed as far aft as possible, but a short intermediate shaft is provided, so that the propeller shaft can be drawn in to allow of a new propeller wheel being fitted. By removing the thrust block as well as the short intermediate shaft, the propeller shaft can be drawn inboard altogether without disturbing any part of the main engines.

The air pump and circulating pump are independent of the main engines, the former being a Blake-Knowles 10-inch by 18-inch by 18-inch by 12-inch twinplex vertical pump and the latter a 10-inch centrifugal pump fitted with high and low suctions and a 6-inch bilge suction.

Engine Room Auxiliaries

All auxiliaries exhaust into the condenser, and when working cargo in port all winches and auxiliaries exhaust into the condenser.

There are two 10-inch by 6-inch by 12-inch duplex pumps installed as a sanitary and fire pump respectively, and the piping is so arranged that either pump can be used as a circulator or air pump on the condenser, thereby avoiding the necessity of operating the main air pump and circulating pump when working cargo in port.

Two 10-inch by 6-inch by 12-inch Blake-Knowles vertical simplex pumps are fitted as main and auxiliary feed pumps respectively and discharge through independent pipe lines direct to the boilers or through the Reilly feed water heater. The feed and filter tank is of 800 gallons capacity and fitted with automatic control for the feed pumps. All drains from traps and auxiliaries are carried back to the filter tank.

A 16-ton Reilly evaporator of the submerged type is also installed for feed water make-up. The independent bilge pump is a 6-inch by 5¾-inch by 6-inch duplex.

Boilers

The main boilers, two in number, made by the Pacific Steel & Boiler Company, of Tacoma, Wash., are also standard Shipping Board design, watertube type. They are designed for 200 pounds steam pressure and fitted with Tracy steam purifiers. The boilers are operated under natural draft and are equipped to burn oil, the Coen direct pressure system being installed with four burners to each boiler. This type of watertube boiler was fully described in the January, 1920, issue of this magazine and was also the subject of a very exhaustive paper presented by Messrs. F. W. Dean and Henry Kreisinger at the annual meeting of the American Society of Mechanical Engineers in December, 1919. This paper gave a complete description of the boilers as well as tabulated results obtained during exhaustive tests. The boilers are placed on the main deck, the stokehold floor being made watertight and placed 18 inches above the deck. This allows all the waste water from washing out the boilers to be delivered overboard, thereby preventing flooding of the deck or engine room.

Fuel Oil System

There are four fuel oil storage tanks in the hold below the boilers having a combined capacity of 1,116 barrels. In addition to this there are four fuel oil tanks amidships having a combined capacity of 1,836 barrels. Settling tanks of 50 barrels capacity each are placed on the port and starboard side respectively on the main deck aft of the stokehold. A 6-inch by 5¾-inch by 6-inch Blake-Knowles duplex pump is installed for transferring the fuel oil from one storage tank to another or from storage tank to settling tank. The duplex fuel oil pumps are in duplicate and the piping is so arranged that they can act as transfer pumps in case of necessity as well as discharge the oil to the burners. The oil manifold, arranged so that oil may be drawn from or discharged into any of the storage tanks, is placed in the engine room with valves for each tank accessible from the starting platform. The filling pipe and valve are also attached to this manifold.

There are six powerful steam winches installed for handling cargo and a steam windlass on the forecastle deck for handling the anchors. There is also a double cylinder steam capstan aft.

The double cylinder steam steering gear is the type made by the American Hoist and Derrick Company, St. Paul, Minn., and operates the rudder by a geared quadrant fitted

* Member American Society of Mechanical Engineers, Seattle, Wash.

with shock absorbers. This steering gear is operated by shaft control from the wheel house on the navigating bridge. There is also a right and left hand screw hand steering gear on the poop deck which can be quickly connected up in the event of the steam gear getting out of order.

The electric light plant is a 10-kilowatt direct connected set made by the Engberg Electric Works, St. Joseph, Mich., and the refrigerating plant is a 1-ton capacity machine made by the Frick Company, Waynesboro, Pa.

When loaded with 1,500,000 feet of lumber and drawing 22 feet 9 inches forward and 23 feet 3 inches aft the *Forrest King* averaged 9.7 knots at sea, the main engines making 91 revolutions per minute and indicating 1,342.97 horsepower. Under these conditions the consumption of fuel oil was 113.8 barrels in 24 hours. This is equivalent to a consumption of 1.18 pounds of fuel oil per developed indicated horsepower, per hour, including all auxiliaries, assuming the oil to weigh 8 pounds per gallon. Considered in all its aspects, the *Forrest King* can be classed as one of the most efficient and economical installations of her class afloat. The machinery installation is very flexible, all emergencies and contingencies being carefully considered and fully provided for, while at the same time the number of auxiliaries is reduced to a minimum.

Commander Gatewood Discusses Ship Repairs With Seagoing Marine Engineers

At a recent meeting of the Ocean Marine Engineers Beneficial Association, No. 80, in New York, Commander R. D. Gatewood, director of construction and repairs of the United States Shipping Board, delivered a lecture on the problems which are now confronting the Shipping Board and steamship owners with regard to the excessive cost of repairs on American ships, both at home and abroad. Commander Gatewood was introduced by Captain C. A. McAllister, U.S.C.G. (retired), vice-president of the American Bureau of Shipping, who called attention to the fact that not only are ship repairs costing 50 percent more than the entire cost of wages of officers and crew every month, but that this expense item amounts to approximately six times the cost of repairs on similar British ships each month, and that it lies within the power of marine engineers to eliminate much of this waste. Commander Gatewood's remarks were in part as follows:

If we build ships at outrageous prices and have to pay interest on that price, we cannot make any money and we cannot keep our place on the sea. We get the same freight rates that everybody else gets. We must make money like other people, and people are not in the shipbuilding business for their health or for pleasure; they are in it to make money.

Again, if we have excessive repair bills we cannot make more money than a country that does not have such excessive repair bills. When I get a repair list from a chief engineer I want to feel that it is a repair list that represents the *absolutely necessary* work on that ship; not merely what is desirable, but what is really necessary to have done—work that he cannot properly do himself.

In the first place, we want to stop the alterations on our ships. At present the alteration bill is more than 40 percent of our total expenses. For the year ending June 30, 1920, the combined alteration and repair bill amounted to the outrageous sum of $85,000,000. If this sum is divided by the number of ships and by the number of repairs and changes, it is apparent how absolutely problematical it must be for us to operate in competition with Norwegian, British and Japanese ship operators. *Alterations must not even be asked for except when they are absolutely essential.*

The second thing we want is to do our own repairs in our own yards with our own workmen. We want to do as little as we can elsewhere. For the two years during the war that I was in charge of the repair shops at Panama there passed through the Isthmus many large Japanese ships that were on very long voyages. During that time these Japanese ships never asked for as much as a bolt or a nut or a stick of wood. Not a single repair did the Japanese ships ask of the facilities at Panama. They had breakdowns, of course, but when anything went wrong they repaired it on the ship, or if they could not do that they waited until they got home and then had the repairs made. If they can do this, we can, but we are not doing it! Our repair bills abroad are outrageous.

A third thing we want to do is to put our repairs on a basis of competitive bids. If the chief engineers will send in their repair lists complete and not come through later with a lot of extras, these lists will be gone over carefully and the needs of each one of the items discussed with the engineers and the necessary work promptly attended to on the basis of competitive bids. The work will be submitted in contracts to all the reliable firms in the various ports. We will let the best man get it and see that he does his work as it should be done.

In that connection we have two very important rules to apply: First, get your repair list in and get it in complete. Let it cover everything that is needed for the voyage. There is nothing more discouraging or unsatisfactory than to get a repair list and then another and another and another. The firm that gets the first repair list simply charges for the extras as much as it likes. In order to effect any economy, the *complete* repair list must be made up at one time. Next, the engineers must help us get what we are paying for. We can have all the inspectors in the world, but they cannot do half as much as the chief engineer who has to stay up nights when something goes wrong with the ship at sea. I would rather have the O. K. of the chief engineer than of anyone else. If you will help us in that respect we will undertake to give you the best service in the world. If you find a repair plant that does not give good quality and will not be reasonable, let us know about it and we will get after that repair plant and they will not have an easy time of it.

The fourth thing, which lies more heavily on my mind than anything else and for this reason I am reserving it for the last, is the *amount of work that should be done by the ship's force.* There is going on in the repairs of our fleet a most discouraging, a most unfortunate, condition that is growing worse instead of better as regards the amount of work that is done by the ship's crew. I do not ask you to go back to the days when almost everything needed was done by the ship's crew, which worked twelve to fifteen hours a day doing it. All that we are looking for is what is reasonable on the part of efficient men who are interested in the efficient management and operation of the machinery of the vessel in their charge. If you could see some of the items that come in to us, you could hardly look one another in the face. You simply could not do it as Americans and efficient engineers. When you submit a repair list, be sure that there are no items in it that are your own jobs or that are jobs which could and should be done by your own crew.

These four points I want to emphasize as strongly as possible. I have no control over the last, other than to appeal to the respect of the conscientious chief engineer which should prevent any unreasonable item being presented that ought to have been done by the ship's own force, but I do have some control over the others, and if you will help me (and you can, enormously, because your engine room repairs cost over 70 percent of the total cost of repairs) and tell others with whom you may come in contact I will be most grateful to you. If you will report all bad jobs there will be less and less trouble and I will give you all the time and attention that a man can possibly give you. In return, please help us along the lines that I have mentioned.

"Economy, Economy and Yet More Economy"

Existing Conditions Make Economy in Ship Operation Imperative—Operating Costs and Repair Bills Must Be Cut Down

BY "OLD SCOTCH"

WHILE claiming no patent right nor even original thought on the subject of economy in shipbuilding and ship operation, the writer can at least claim for the past ten years many contributions on this very important subject in the columns of MARINE ENGINEERING. During our past four years of national "jag" in shipping matters, but little attention has been paid to any of these preachings: they have figuratively been ruthlessly brushed aside by such remarks as "No time now for tight-wadism," if such a term may be used.

Now, however, we find the subject uppermost in everybody's minds, and it is acutely present in all dissertations on national, state, municipal and private affairs. The first period of the "morning after" is running true to form, as evidenced by the many good resolutions we are considering and adopting. Also, like our prototype, the reforming "souse," we are showing tendencies of going to extremes in our wild endeavors at reformation.

EXTREME MEASURES IMPRACTICAL

If you do not think so, just read the Washington despatches containing information of the intent of certain congressional committees to cut off all appropriations for the Shipping Board activities, both building and operating. Of course, our national lawmakers are not going to take such a radical step, as it would leave all our shipping activities on their beam ends, but such propositions as have been made are indicative of the extremes to which we, as a nation, are at least considering in the wild scramble to remedy the shortcomings of several years' profligacy, in a few months of acute reformation. It's a good sign nevertheless that out of it all will come considerable reductions and economizing in our national expenditures for shipping and other functional activities of Government.

The officials managing Shipping Board affairs are now thoroughly aroused to their task, and decreasing expenditures for repairs and operations tell the tale of their efforts. The present Director of Construction and Repairs, Commander Gatewood, has called conferences of the leading operators and repair men in New York and vicinity and urged their hearty co-operation in cutting out needless and wasteful expenditures on the Government fleet. He has been promised their assistance, as they recognize in his efforts a sincere and earnest endeavor on the part of the Government to introduce rigid economies in its fleet of Shipping Board vessels, still the predominating part of our merchant marine.

THE DEPRESSION IN SHIPPING

Already we are beginning to reap some of the bitterness of the intense rivalry we must meet on the seas. The mere fact that many of our sea going craft are tied up to the wharves and idle is not so discouraging in itself, as the daily press advises us that we are not alone in having idle ships. All other maritime nations are having the same depressing experience. The most disturbing indication is the fact that one of our large oil companies has recently found it necessary to tie up some of its American and British case oil carriers plying to the Orient, because Japanese ships can carry these cargoes and make a profit at a freight rate less than the actual cost of transportation on the American and British ships, which have been engaged in the same trade. It must not be assumed that this condition of affairs is going to continue indefinitely, for if it should, we might as well go out of the ocean carrying trade at once. It must, however, bring acutely to our thoughts the reasons and remedies for this state of affairs. None of us will be willing to admit that in normal times the Japanese can build ships so very much cheaper than the Americans and British, handicapped as they are, in costs of material and less efficiency of the labor entering into the construction of their vessels.

EXCESSIVE OPERATING COSTS

Such a great discrepancy in the freight rates between the vessels of these three nations must largely be accounted for in the operating costs. Fuel, canal and port charges will be the same for all vessels, so that the great advantages must lie in the lesser costs of wages, food and repairs on the Japanese vessels. We can never expect nor do we desire that wages of American officers and men shall be reduced to the level of that received by the Asiatics, and this item must be compensated for in "adjustments" made possible by our Government in some preferential treatment of its merchant marine. The costly items of repairs and upkeep are probably the most serious with which we have to contend, and this largely resolves itself to the question of relative efficiency of engineering personnel.

The writer recently was informed by a former official of the repair shops maintained by the United States at the Panama Canal that, in the course of several years' observation of the craft of all nations using the Canal, while American and British ships were the most frequent patrons, he had yet to witness the expenditure of a single dollar for repairs by any of the numerous Japanese ships which passed through this great waterway. While this fact speaks volumes for the efficiency of Japanese engineers, it also points out to us where a decided reform can be made on our own ships, and which possibly may be of sufficient import to account largely for the present condition in freight carrying herein cited.

ECONOMIES IN SHIP REPAIRS

Great economies have already been made in the cost of repairs on our ships, but further economies can and must be made. While it has been quite popular to speak of the rapacity of repair men in our American ports, and to the lax methods of the operating personnel on our ships, the fault is not entirely with these two classes by any means. One of the most important elements in the cost of repairs is the supervisory force, that is the inspection and specification writing people, upon the thoroughness of whose work the expense of making the repairs very largely depends. Superficial inspection and indefinite specifications have been and are still very great sources of wasting money for shipowners in the matter of repairs, and immediate reforms along those lines are paramount.

It is so easy for a man writing specifications to use broad general terms such as "Main feed pump to be thoroughly overhauled and put in first-class working condition," "Steering engine to be overhauled and made to operate successfully with the vessel at full speed," "Port forward boiler to be repaired and made tight under steam at working pressure," etc., etc., and then conclude with that old-fashioned glittering generality "All parts repaired under these specifications

must be made to operate to the entire satisfaction of the inspecting officer: any omissions from these specifications necessary for the successful completion of the repairs enumerated must be furnished by the contractor."

The inefficient and lazy man writing such specifications lies back in his office chair, with the snug satisfaction that he, at least, has performed his function and has protected the shipowner in every way possible from the "rapacity" of the contractor. Anything that he, in his wisdom, has failed to include in his literary effusion will have to be furnished by the "party of the second part," at his own expense, the latter "his" being the meek and lowly contractor.

Let us look on the side of this "party of the second part." In making his estimate, he must, in the case of the feed pump for example, provide against almost any condition which may arise when the pump is taken down, and for the whim of the inspector who will pass on the work. What is the result? The contractor, to protect himself against these contingencies, must name a figure which will cover anything that might arise in connection with the proper functioning of that particular pump in the tests which will be given it, under the broad terms of the loosely drawn specifications. Can you blame them?

How much better and less expensive it would be for the inspector or specification writer to go over that pump with one of the ship's engineers familiar with its delinquencies and find out definitely just what ails it. If a new piston rod is needed for one of the steam cylinders, say so, and give its material and size or other means for identifying just what is to be done and no more. If new valves are said to be needed on the water end, find out just how many new ones are needed, or what repairs are needed to make the old ones function properly. Many and many times, I dare say, in the past few years it would have been much cheaper to have purchased and installed a brand new pump or other small auxiliary than it would have been to make these "general repairs" specified by incompetents.

Competition for business nowadays has largely done away with "gouging" on the part of the contractors for ship repairs. Any one of them, I feel assured, would rather bid on work where it is specifically stated just what he is required to do in definite terms which need no discussion as to their true intent and meaning. No honest contractor, and my experience with them leads me to believe that the great majority of American ship repair men come under that category, wants to be under constant suspicion that he is unduly profiting on the American merchant marine. He must, however, protect himself from *losing* money, and if he has to deal with loosely drawn specifications, it is not his fault that he does look after his own interests.

Times like we are now passing through have a wonderful chastening effect on all of us. We now have time to consider our efforts carefully and to introduce reforms that have heretofore been neglected in the days of "easy money." If we all, individually, take these opportunities to mend our ways, we can as Americans keep our ships sailing the high seas in competition with any and all our competitors. But without strict economy we will run a losing race.

How United States Government Reorganization Will Affect the Merchant Marine

BY WALDON FAWCETT

During the closing days of 1920, *there was enacted by the Congress of the United States a legislative measure that will have lasting influence of wide scope upon the American merchant marine, and, more specifically, upon the governmental agencies that have contact with shipbuilding and shipping interests. Briefly, the law lately placed upon the statute books paves the way for a complete reorganization of the executive branch or administrative system of the United States Government. At least a year will ensue ere its effect will begin to be transmitted to the indusry, but ultimately the consequences, direct and indirect, will prove of moment.*

As may be surmised, the organization of a joint commission of the United States Senate and House of Representatives to bring about a reorganization of the alministrative branch of the national government injects a new element into the proposal, already reported in these columns, to abolish the United States Shipping Board and vest the control of governmental shipping and shipbuilding property in a Department of the government, headed by a member of the Cabinet. The authorization, in general terms, for an overhauling of the machinery of the government does not specify, as part of the programme, the elevation of the structure of the Shipping Board to departmental status, but, obviously, with the spirit of reorganization in the air, the proposal for the transformation of the Shipping Board will receive more attention than it could gain as an isolated enterprise.

Especially is there opportunity to urge that a merchant marine department be instituted, inasmuch as sponsors of the idea have never contemplated a mere change of name for the Shipping Board, but rather an amalgamation that would associate with the organization now known as the Shipping Board all the existing bureaus and agencies of the government having to do with maritime affairs. This idea of co-ordination and consolidation establishes a bond of sympathy between the special merchant marine project and the general programme of administrative reorganization. The underlying purpose of Congress in the planned shake-up at Washington is to put an end to the ever-increasing and expensive duplication of government work. And the remedy is expected to be found in a "boiling down" that will dispense with the superfluous.

Duplication of Government Work

Shipping and shipbuilding men have probably had comparatively little knowledge or first-hand experience with duplication of government work, because this evil has not been flagrant in their sphere. Indeed, the movement to gain better status for Uncle Sam's merchant marine annex has been prompted not so much by internal conflict or duplication of effort as by the conviction that it would be advantageous if the federal forces of the merchant marine could, at all times, have representation in the Presidential Cabinet and a voice in the councils where are formulated our national policies. But while there is little "doubling" in service of the

merchant marine, the evil has grown to flagrant proportions in other governmental quarters, as is not unnatural, perhaps, seeing as how there has been no revision of the organization chart since the government set up in business.

Statistics compiled some years ago indicated that if the United States Government was operated as a large private business is conducted there could be a saving in operating expenses approximating one million dollars a day. An estimate made a few weeks ago places at $500,000,000 per annum the saving that will be possible under a proper consolidation and elimination of governmental activities. Aside from the sheer waste that results from obvious duplications of effort, there is the further consideration that overlapping jurisdictions by many governmental agencies as now constituted has resulted in friction that in some instances has impeded progress.

Concentration of Governmental Maritime Agencies

Whether or not the joining of the whole broad issue of governmental organization results in the creation of a new executive department with the functions or structure of the Shipping Board as a nucleus, it is a foregone conclusion that the shake-up will result in a regrouping of the federal agencies that have contact with shipping. That is to say, if none of the existing agencies be absorbed or supplanted, at least there will be realinement. Every tentative plan of government reorganization that has been put forward in Congressional circles contemplates a new line-up of the maritime agencies of the government.

Assuredly there has been need for selective association, dating from the days before the Shipping Board was even thought of. No other great industry and instrumentality of public interest has had its governmental agencies so scattered and isolated. There has been effort, partially successful, to be sure, to concentrate in the Department of Commerce the institutions that deal with maritime responsibilities. In consequence, we find in this executive division the Bureau of the Census, Bureau of Standards, Bureau of Fisheries, Bureau of Lighthouses, Coast and Geodetic Survey, Bureau of Navigation and Steamboat Inspection Service. However, there is yet room for closer affiliation in the interest of interdependent efficiency, as witness the fact that Coast Guard is under the jurisdiction of the United States Treasury, the Mississippi River Commission and the Board of Engineers for Rivers and Harbors are under the War Department, the Navy Department has the Hydrographic Office, and the storm forecasting service, that is essentially for the benefit of maritime interests, is in the province of the Department of Agriculture.

Co-operation Desirable

As has been said, every tentative proposal for the readjustment of the federal administrative machinery recognizes that the interests of the merchant marine and of the nation's waterborne commerce require consistent affiliation in behalf of team-play. Thus, the programme worked out by Senator Medill McCormick, of Illinois, proposes to make of the existing Department of Commerce a comprehensive clearing house for shipping and commercial interests, and to that end would transfer to that department the Weather Bureau, the Patent Office, the Coast Guard, Hydrographic Office, Naval Observatory and the inland and coastwise waterways services now within the jurisdiction of the War Department. Another suggestion, born of the present agitation, calls for the consolidation of all the "engineering" activities under one administrative organization. The outstanding objective, however, is the reduction to a minimum of the independent bureaus of the government which have multiplied extravagantly in recent years. And it is just this aspect of the undertaking that renders it certain that question will be raised whether the Shipping Board should be allowed to preserve its individuality.

Centralization of Purchasing Power

One assured feature of the scheduled reorganization of the government will communicate its revolutionary influence widely in shipbuilding and ship supply circles. This will consist of a centralization of governmental purchasing power, in the train of which will come standardization of governmental specifications. It is stated that, as matters now stand, no less than seventy different governmental agencies have authority to requisition or purchase supplies. As many shipbuilders and marine outfitters can testify, this has resulted in confusion and a woeful lack of standardization. Also, as has been spectacularly demonstrated by recent happenings in the coal market, the condition has permitted one branch of the government to bid against another, to the demoralization of the commercial market. There is a feeling in Congress also that it would be an excellent idea if the project for a central purchasing agency could be balanced by a plan for a central salvage bureau that would undertake the orderly disposition of all surplus government property. It is claimed that with such a clearing house functioning intelligently it would be possible in many instances to divert equipment and supplies unneeded in one quarter to other federal institutions where the material could be used to advantage, thus saving money for the government and at the same time avoiding unnecessary derangement of the commercial market. This question is, of course, one that is just now acute in shipbuilding and maritime outfitting circles owing to the activities of the Shipping Board in offering for sale surplus materials of various kinds.

Economy and Efficiency

The impending reorganization of the administrative machinery of the government will not only result in greater cohesion of merchant marine activities, but, in furtherance of ideals of economy and efficiency, contemplates more compact facilities of administration. Indeed, in the discussions incident to Congressional action providing for reorganization, the Shipping Board's and Emergency Fleet Corporation's expansive offices were cited as a shining example of waste and extravagance. As an "exhibit" in proof of the charge, there has been prepared an itemized statement of the rental payments of the Shipping Board for quarters in privately owned buildings in Washington and Philadelphia.

For the office building located at 1319 F street, N. W., Washington, D. C., the Shipping Board pays an annual rental of $51,261. For the adjoining building at 1317 F street, likewise used for office purposes by the Board, there is paid annually $35,018.40. In addition to these rented buildings in Washington the Shipping Board now pays for rented quarters in Philadelphia $70,000 for the building at 329 South Broad street, used for offices, but in part subleased to other tenants; $275,000 for the building at 140 North Broad street, used for offices, but in part subleased to other tenants; $95,000 for the building at 921 Delaware avenue, subleased to other tenants, and $32,000 for the building at 253-255 North Broad street, now subleased to other tenants. Congressmen who are keen for concentration and consolidation argue that the entire staff and complete files of the Shipping Board and Emergency Fleet Corporation could be accommodated in the huge building at Washington, erected during the war to provide quarters for the temporarily expanded Navy Department, and that this removal, in addition to placing the merchant marine institution in close contact, as it should be, with the Navy Department, would stop the rental of $86,279.40 in Washington and the rentals in Philadelphia, which aggregate $472,000, and all of which would fall upon the government should the tenants who are now subleasing from the Shipping Board elect to vacate.

Retrenchment

With our eyes turned upon the financial side of the government's activities in the merchant marine field, it is fitting to

mention that Congressional effort for a shake-up in Shipping Board policies and practice will not even wait upon the reorganization that is promised in the future. A spirit of insistence that the Shipping Board shall contribute its full share to the immediate retrenchment of government expenses has been manifest in Congress this winter in connection with the making up of the governmental expense account for the fiscal year 1922. Officials of the Shipping Board have been mercilessly cross-examined by the Committee on Appropriations of the House of Representatives, which is charged with the duty of framing the "supply bills," and as a result of the inquisition the appropriations for the use of the Board will be much less than the estimates submitted to Congress for approval.

Congress has not definitely decided upon what financial basis the Shipping Board and Emergency Fleet Corporation will carry on their business during the coming year. Beginning July 1, 1921, it is probable that the plan will call for lump appropriation for a year's operations. Under this new procedure the Shipping Board called for an initial annual appropriation of $147,000,000. A considerable portion of the funds have been asked for the use of the consolidated department of construction and repair which has under construction but uncompleted a total of 95 vessels, the estimated aggregate cost of which will be $163,000,000. It is figured that to carry on the work on the vessels under construction during the first six months of 1921 will require a sum totaling $130,000,000, which expense will presumably have to be taken care of by a "deficiency appropriation." The finishing touches to the new vessels, in the period following July 1, will necessitate, it is estimated, an outlay of about $33,500,000, which would come out of the total allowance of $147,000,000 which is sought for all Shipping Board operations next year. Up to the present writing Congress has shown a disinclination to grant the above appropriation.

Estimate of Tonnage Deliveries

In this connection the Shipping Board has prepared for the use of the Congressional committee an estimate of deliveries of tonnage during the year 1921 that may be of interest to the industry. During the first half of the present calendar year deliveries are counted upon, in deadweight tons, as follows: January, 187,350; February, 114,950; March, 68,000; April, 61,900; May, 103,900, and June, 98,100. In July the expectation is for deliveries of 20,200, and in August 36,000. In September there should be deliveries of 24,000; in October a Sparrows Point delivery of 13,000, and in November a delivery of 11,000. This will leave delivery of 13,000 for January, 1922, and an equal tonnage in April of that year.

In recent conversation with members of the Appropriations Committee, Commander R. D. Gatewood, Director of Construction and Repair, has stated that construction on the government contracts is proceeding in the main "very satisfactorily" principally for the reason, he believes, that there is not a great deal of other construction going on, and in consequence of the fact that the efficiency of the construction plants is being raised all the time due to the readjustment of industrial conditions. Incidentally, this official, in discussing the sale of ships—sales having totaled 449 to date— remarked that, although sales prices have been modified twice, it might be necessary to modify the figures still further, inasmuch as the vessels "are not moving very fast." Incidentally, Commander Gatewood remarked that the expense of repairs to Shipping Board vessels is being heavily reduced. For the first half of the calendar year 1920 the repair bill averaged $6,500,000 a month. During the last half of the year the outlay was scaled down to $4,500,000 per month and the Director remarked that "they are going to get materially less."

Committeemen at the Capitol quizzed Commander Gatewood quite pointedly on the comparative cost of ship repair work in United States navy yards as compared with private yards, and he reported that the expense of work performed at navy yards is 20 percent more than the work done on a comparative basis in private yards. He attributed the discrepancy to the high overhead carried in the navy yards. By his estimate the average overhead in the navy yards is 80 to 100 percent, and to this he attributed the excess cost of navy yard repairs rather than to any lack of efficiency on the part of navy yard workmen. Asked why the Shipping Board uses the navy yards for even 5 percent of its repair work, Commander Gatewood made a significant disclosure of policy. He said:

Cost of Ship Repair Work

"It costs 20 percent more, but there is a distinct object in having repair work done in navy yards. By using the navy yards you get a somewhat better quality of work, which helps to make up for the difference in the cost from using navy yards. By using navy yards you have at all times a fully equipped plant to which you can send your vessels, if you think that the cost at private yards is excessive in any given locality, or that the quality of the work is not what it should be. The navy yards thus far have been used almost entirely as counters against excessive private yard costs."

The chairman of the Appropriations Committee was inclined to criticize this policy sharply. Pointing out that the Labor Wage Adjustment Board reported not long ago that there was a difference of at least $240 per annum between navy yard wage scales and the present wage scale of the private shipbuilding industry, he said: "Now, in order to find increased work for men who can be employed at higher wages than in any other industries in the United States, you go to work and dump several million dollars worth of additional work into the navy yards, requiring more employees and more men at a higher rate of wage than is paid to workmen in like industries. I do not see any sense in that sort of arrangement."

The Shipping Board executive defended his policy by reiterating: "The purpose of the Shipping Board in using navy yards is entirely to make it clear to private contractors whose costs are excessively high, or much higher than they should be, that we have another place to send our work on occasions if they do not want to keep the costs at a point that we think is reasonable. It would be grossly unfair for the Shipping Board to assign such a large proportion of its work to navy yards as would put the private yards out of business, or so greatly reduce the volume of the business of the private yards that they could not operate efficiently, and we have not done so to anything like that extent."

Progress of the "Isherwood System"

The annual report on the progress of the "Isherwood system" of ship construction for 1920, contains the following table giving the number and total deadweight tonnage of Isherwood framed vessels built throughout the world each year since this system was applied to shipbuilding. While this table is confined solely to Isherwood ships, it, nevertheless, indicates the fluctuating phases in shipbuilding generally throughout the world.

	Number of Ships	Deadweight Tonnage
September, 1907 to December, 1908	6	31,608
1909	36	212,992
1910	76	484,752
1911	140	958,795
1912	240	1,777,348
1913	270	1,993,034
1914	311	2,351,322
1915	468	3,548,221
1916	620	4,666,000
1917	800	6,332,150
1918	1,050	8,707,700
1919	1,260	10,594,700
1920	1,395	11,952,400

Mold Loft Suggestions

Shell Expansion—How Practical Problems Are Worked Out on the Mold Loft Floor

BY J. I. HESS*

FROM a practical point of view there is a limit to the amount of work that can be done in the loft, though there is nothing that cannot be done with a satisfactory degree of accuracy, theoretically speaking. This limitation is due primarily to the difficulty in holding the ship fair during construction, for when completed it seldom conforms to the body plan in every detail. For this reason a template may be perfect in every respect, according to the loft, and be useless when applied to the ship. This condition is greatly aggravated by the practice of lifting various bounding bars and other connections that can be perfectly molded. If these members were supplied by the loft and used as early as possible in the course of erection, they would help to keep the ship fair and would insure a better fit in the members that are to follow. But the work must be *right*.

It sometimes happens that the loft will turn out a template with every confidence in its accuracy, and yet it may contain serious errors. This is not because the loftsman is careless or has not given the work his best efforts, but it may involve a problem in descriptive geometry that has never been called to his attention.

These oversights on the part of the loftsman are more liable to occur in the newer yards that have been working under the handicap of more or less unskilled labor. It is for this class of workman that these notes are prepared; but since the method of treatment of the various questions taken up here is entirely original, it is possible that the older and more experienced craftsman may find them of interest. To be able to follow the solutions offered one must have a fair knowledge of descriptive geometry and some trigonometry, though such knowledge is not necessary for the practical application of the results.

Shell Expansion

Perhaps the most interesting problem that confronts the loftsman is the expansion or development of the shell and other warped surfaces. With varying degrees of success every man who has worked with the lines on the floor has experimented more or less on some method of doing this work. The majority of those who have learned anything have kept it to themselves as a "trade secret." For that reason they surround the work with a great air of mystery, some loftsmen even going so far as to put in a lot of extra motions just to make it seem more difficult.

Any solution that is mathematically correct will give accurate results, if proper care is used in applying it. It must be so accurate that both inside and outside strakes can be laid out from stem to stern with absolute certainty that they will fit, provided, of course, that equal care is used in assembling on the ways. But accuracy is not the only requisite. It must be simple and rapid and easily handled. The method offered here qualifies, I believe, under these requirements.

Most loftsmen are familiar with some method of finding the true length of a line projected on the body plan, but those who are new to the work will be interested in a brief analysis of the method that seems to be the simplest and most nearly accurate.

In the portion of a body plan shown in Fig. 1, *AB* and *CD* are the lower and upper edges respectively of two outside shell plates, "*J*" and "*G*." It will be noticed that these lines locate the edges of the inside plates as well, for the width of the "skin" plates is found at any point by taking the girth of the frame at that point between the lines *AB* and *CD* and

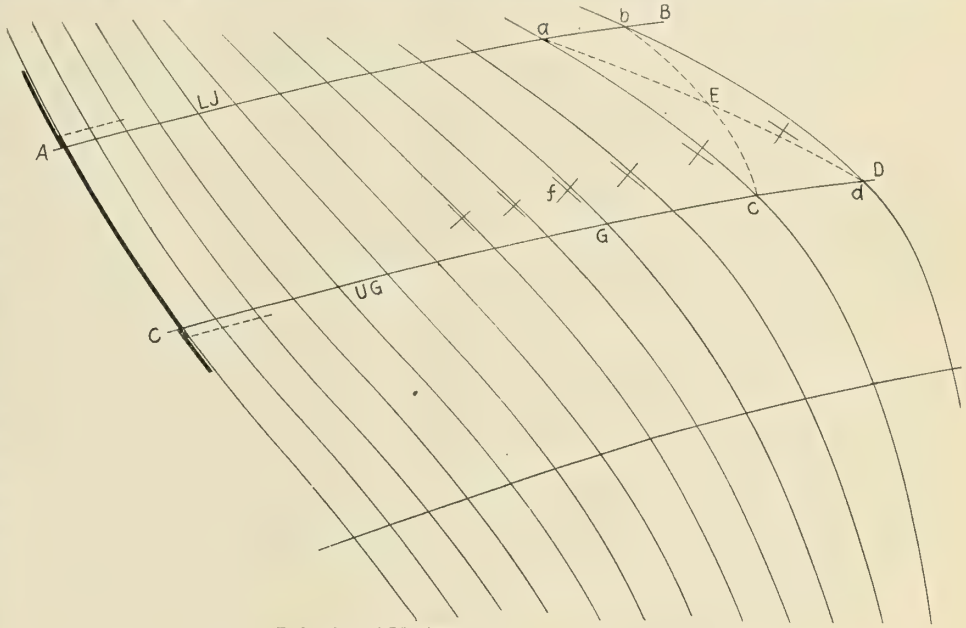


Fig. 1

adding the width of seam at top and bottom, as shown at *AC*. But that is a later consideration. The first step in the development of either the inside or the outside plate is to find the true length of the lines representing its edges. If we bend a batten along the line *CD* and pick up each frame intersection on it, these points, when measured from a common pitch mark or base on the batten, will be the ordinates of the curve made by the line *CD* on the side of the ship, or the curve that would be made if a plane were passed through *CD* perpendicular to the shell.

If the loft is not crowded, fence off a space as long as possible, and draw the frame lines on the floor with fore-and-aft spacing full scale. On these lines, and from any base as shown in Fig. 2, set up the points just lifted on the batten. The resulting curve is the true shape of the edge of the plate as it is on the ship, and a long batten bent around this curve and marked with the frame intersections gives us the true length of the line. The distances between the marks on the batten are the expanded frame spaces.

It must be remembered that the curve thus made is the molded edge of the plate, or a line on the heel of the frames. After the points are located on the floor, select two battens approximating the thickness of the inside and the outside

*Formerly mold loft foreman, Ames Shipbuilding & Drydock Company, Seattle, Wash.

plates—say 5/8-inch—and pin them on the floor side by side, as shown in Fig. 2, so that the inside edge of the batten representing the inside plate is on the points, or molded line. (If the curvature is very great, the thickness of the battens is important.) Square up and across as shown. These battens, when straightened out, give us the required lengths of the inside and the outside strakes on the line *CD*.

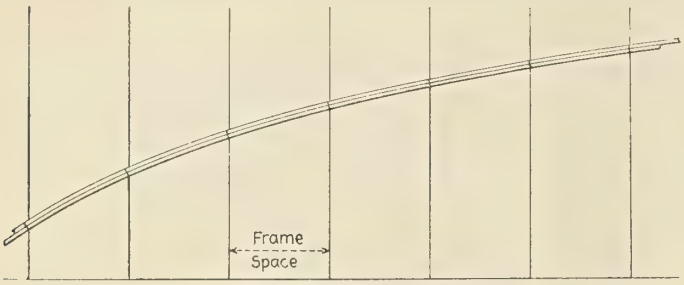


Fig. 2

You will notice that the outside batten is a little longer than the one on the inside, due to its greater radius of curvature—a detail usually overlooked.

If the facilities of the loft permit, it will be found advantageous to run this line from the midship section clear through to the stem—or the stern as the case may be—at one operation. Develop each "sight edge" the same way. Number the frames and label the battens so there can be no confusion; tie them in bundles for each strake and pot them in the racks for future use. (In some cases, one may even go farther and space in the seam holes while the battens are on the floor, but I have found it more convenient to keep a record of the seam holes on a special batten lifted from the template of the inside strake. If a double riveted seam is used, cut a batten the proper width to fit in between the gage lines and pick up the holes on each edge of the strip. Don't forget to transfer the molded lines of the frames to it also, for in applying it to the outside strake it will be found necessary to move the strip ahead occasionally to make up for the difference in length.)

Again let us consider a portion of the body plan, Fig. 3. Let *AC* and *BD* be two adjacent frames, and *AB* and *CD* the top and bottom edges, respectively, of the shell plate

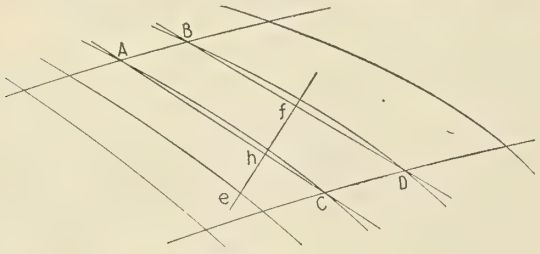


Fig. 3

under consideration. From the theory of the body plan, we know that the two frames each lie in a plane that is parallel to the plane of projection—body plan—and separated from each other the distance of one frame space. Draw the straight lines *AC* and *BD* through the intersections of the frames and the edges of the plate. Since the points *A* and *C* both lie in the same frame, the straight line *AC* must lie in the plane of the frame and be parallel to the plane of projection. Hence, if we draw any line, *ef*, perpendicular to *AC*, its projection on this plane (body plan) will always be perpendicular to *AC* no matter what its inclination to the plane of projection (bevel). In other words, if we pass a plane through *AC* and *ef*, and use *AC* as an axis of rotation, the points *e* and *f* will move along the perpendicular line *ef*, and when this plane stands perpendicular to the plane of the body plan, the points *e* and *f* will coincide in the point *h*.

To simplify the explanation further, let us assume that the frames are represented by the straight lines *AC* and *BD*. If one end of the shell plate be fixed at the frame *AC*, and the plate unwrapped from the side of the ship until it lies in a plane parallel to that of the body plan, the frame *BD* will be seen to move away from the frame *AC*, until the distance between them is that of the expanded frame space. Since

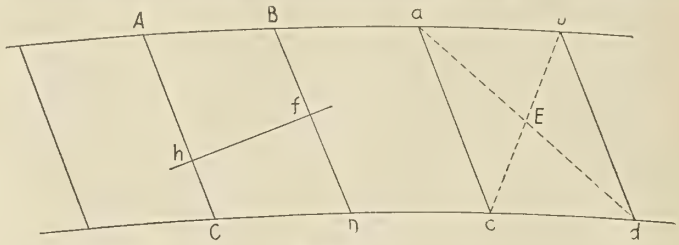


Fig. 4

the point *f* must always lie in the line *ef*, the intersection on *BD* is fixed and must be the same on the developed plate as on the body plan. That is, if Fig. 4 represents a portion of the developed plate, *Ch* and *Df* in Fig. 4, must equal *Ch* and *Df*, respectively, in Fig. 3.

It makes no difference where the line *ef* crosses *AC*. It may be either sight edge, or any other convenient point in between, but for various reasons it is easier to handle if the point be chosen, so that the line squared ahead will intersect the next frame within the edges of the plate.

Construct a "square" of any suitable material—hard wood is preferable—about the dimensions shown in Fig. 5, with all joints mortised in so that it will lie flat on the floor. The arm *AB* should be long enough to span the widest plate to be encountered. The upper edge of *AB*, and the right hand edge of *CE*, should be as nearly unobstructed as possible, for these are the working edges. It will be noted that the arm *ED* serves no purpose, but to help hold the arm *AE* straight and rigid. If it be possible to get a square made of light steel, this arm and brace may be eliminated. It must be as nearly square as possible, for, if not, the error will be accumulative and may result in disaster. To guard against this, check its

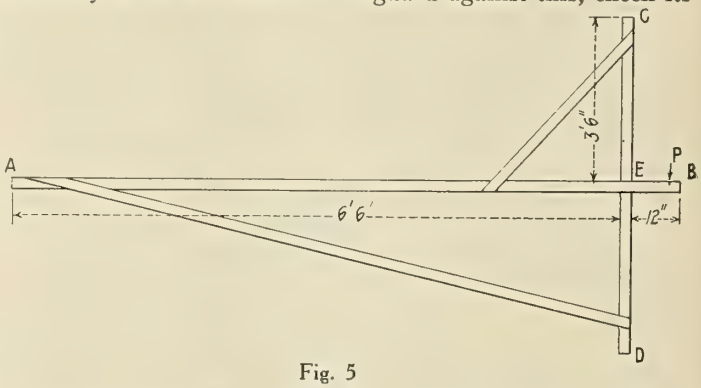


Fig. 5

accuracy occasionally, for even the most carefully constructed square may warp a little.

Select any pitch mark *P* on the arm *EB*, and use this throughout the process of development. The only thing that determines its location is: the arm *CE* should intersect the next frame within the edges of the plate as before stated. Lay the square on the body plan with the arm *AB* through the intersections of the frame and the edges of the plate and with the pitch mark *P* on one edge. (It doesn't matter on which edge the pitch mark is placed, for the result is the same, whether the squaring process is done toward the stem or toward the stern. Only it must be remembered that later, when the work of development begins, the same edge must be used and the work carried out in the same direction as laid out on the body plan.) Mark along the arm *CE* on the floor at about the place where the arm *AB* will be in its next

position. Move the square ahead to the next frame and mark along the arm *AB* to intersect the line just drawn; then mark along the arm *CE* and repeat the process. When the work is completed, the body plan will show a series of small crosses as shown in Fig. 1.

In the case of an outside plate with considerable curvature in the frames, it may be found advisable in a few instances to square out a distance of one and one-half times the thickness of the plate from the molded line to the neutral axis of the plate for points on which to apply the square. If the plate is clinker construction, or with one edge in and one out, it must be treated accordingly. That is, one end of the square will be applied to a point squared out from the molded line a distance equal to the thickness of the inside plate. Theoretically, one should in all cases work from the neutral axis of the plate, but the results obtained are not commensurate with the work required. Numerous tests have shown that except for the cases noted above the results are almost identical with those obtained when working from the molded line. This is more easily understood when it is remembered that we are working from a straight line between the edges of the plate. The curvature of the frames is taken care of with the girth battens.

Select several very thin battens about as wide as the thickness of the plate and long enough, when bent around the frames, to span the plate. (The width of these battens is important.) If it is an inside, or skin plate, bend the batten with its inside edge on the molded line. But if it is an outside plate and there is much curvature in the frame, the girth measured will not be right unless the batten is moved out from the molded line, the proper distance to allow for the inside plate and liner.

While the batten is bent in this position, transfer to it the two sight edges and the heel of any longitudinal, stringer or deck bar that may be shown. Release the batten from the floor. Hold the sight edge on which the pitch mark of the square was applied and, with the batten *straight,* pick up the point of the cross. This distance corresponds to *Gf* in Fig. 1. Move the batten to the next frame and repeat, being sure to hold the same sight edge each time—the one on which the pitch mark of the square was applied—so that the variation in the girths will all fall on one end of the batten. The marks must be distinctly numbered to avoid confusion. If they become too close to permit this, take a new strip. This will give us all the data necessary to lay down the outline of the plate.

Select from the rack the two long battens representing the edges of the strake desired. Tack one end of each to the floor, properly spaced from each other with the girth batten for that particular frame. Move the girth batten ahead to the next frame and lightly tack the end with the pitch mark in place, leaving the other end free. Now place the square on the frame just fastened to the floor, with its pitch mark on the edge batten. Be sure that the pitch mark on both the square and the girth batten is applied on the same edge that was used on the body plan. Move the edge batten at the point where the girth batten is fastened to it, until the proper point on the girth batten falls under the arm *CE* of the square, then fasten it to the floor. Space the other edge batten to give the proper girth and tack it to the floor also. Move the square and girth batten ahead and repeat. A loftsman and helper, standing facing each other, one handling the square and the other the girth batten, can do a surprising amount of work in a short time.

When the strake is tacked to the floor, it is time to check for errors. If the work is carefully done, the chance of serious error is slight, but there is a lot of satisfaction in knowing that any such error can be determined with absolute certainty. If the double diagonals, *ad* and *cb,* in Fig. 4 are checked at each end of the strake and in the middle and found correct, it is safe to assume that the work as a whole is correct.

On the body plan, as in Fig. 1, the projections of the diagonals will not be straight lines but will be curved as shown by *ad* and *cb*. Geometry teaches us that the diagonals of a parallelogram meet in a point that is equidistant from the opposite sides. The surface under consideration is not a true parallelogram, but from frame to frame the approximation is close enough for all practical purposes. Hence, with the point *E* located midway between the sides, it is only necessary to bend a batten through the three points to get the projection of the diagonal. Pick up the girths of these diagonals as was done with the frames. Lay these lengths off on the leg of a right triangle, the other leg of which is one frame space, and the resulting hypothenuses

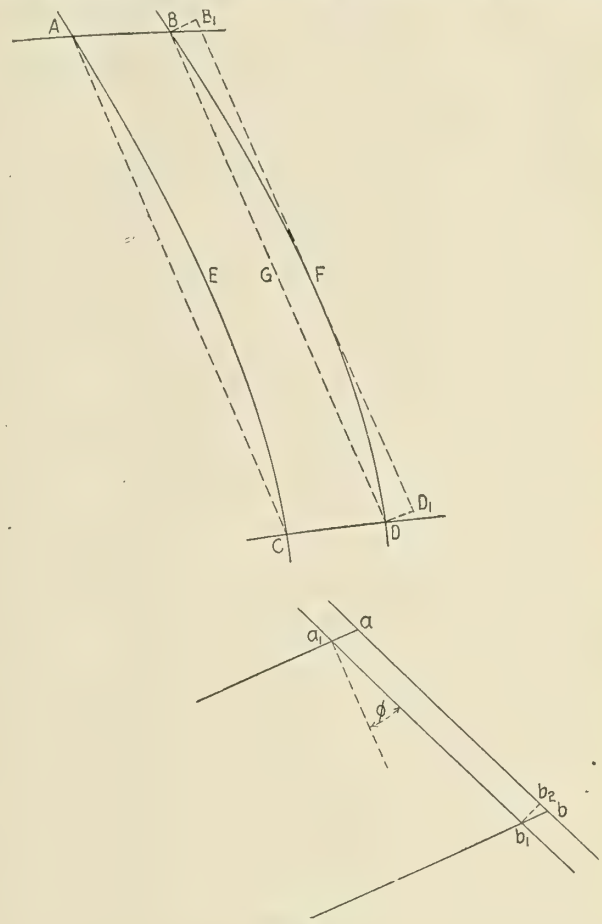


Fig. 6

will be the developed length of the various diagonals and should fit the developed plate. If there is much curve in the plate, a slight error will creep in here, due to the fore-and-aft curvature of the diagonal not shown on the body plan. However, it is so slight as to be negligible.

Having proved that the development is correct, it remains only to draw in the frame lines and build the templates. Much time will be saved in making the templates, if the edge battens are so placed that the working edges are on the inside for an outside plate and on the outside for an inside plate. This will allow the templates to be built right over the battens without having to take them from the floor and it saves the time of transferring the points and lines to the floor and the danger of confusion later.

If there is any noticeable curve in the molded frame, and appreciable bevel, the frame will not cross the developed plate in a straight line but will curve in the same direction as is shown on the body plan. That is, if on the body plan the curve is convex toward midships, or toward the "wall," the curve will be convex toward midships on the developed plate. This deviation from a straight line is determined as follows:

In Fig. 6, let AC and BD be sections of two adjacent frames, AB the upper edge and CD the lower edge of the shell plate under consideration, as before. Draw the straight lines AC and BD. Now let us take a projection of this figure in a plane that is perpendicular to BD; then B and D fall in the point b_1 and F falls at b. For the purposes of this demonstration, we may assume AC to be parallel to BD and treat it similarly. This gives us, then, a view of the plate in which the line a_1b_1 is a projection of both the top and the bottom edges, and ab is a line through the extreme outside of the curve, or the approximate center of the plate. The frame's variation from a straight line on the body plan is shown in the vertical projection by the distance FG, and in the horizontal projection by b_1b.

Suppose we consider ab a fixed line around which the upper and lower edges of the plate must move in order to give it the flat shape it has when developed. It will be seen that in this operation B moves to B_1 and D to D_1. Also, b_1 moves to b_2 and travels in a line that is *perpendicular to ab*. By a simple rule of descriptive geometry, this line b_1b_2 must be a straight line on the developed plate.

This shows us that for a frame to be straight on the expanded plate, one of the following conditions must exist: either the frame itself is straight, or it has no bevel. If the frame is curved and has no bevel, as in the bilge amidship, b_1b coincides with b_1b_2, and is perpendicular to ab, hence develops into a straight line. If there is bevel and the frame is straight, then b_1 and b_2 coincide with b and the developed frame is a straight line.

Since the line that develops straight on the plate must be perpendicular to ab, any other line such as b_1b will vary from this straight line the distance bb_2 at its point of greatest curvature. (With a constant curve in the frame on the body plan, this distance varies with the sine of the angle of bevel. If the bevel of the frame is constant, then this distance bb_2 varies directly with the amount of curve bb in the frame line on the body plan.)

The writer has devised an instrument, shown in Fig. 7, for applying this principle in practice. It is built of light wood and all joints are mortised in so as to be flush on both sides. This allows the instrument to lie flat on the floor with no interruption to the free swing of the arm BG. AB is a straight edge, long enough to span the widest plate shown on the body plan, and made at right angles to the scale DF, which is laid off in inches with the graduations on the upper edge. This makes it possible to measure the hypothenuse of the right-angled triangle made by the small movable square, as shown at b_1b. CD is also a scale in inches, about 8 inches or 10 inches long, with the zero end at C, but with the graduations on the lower edge, to be used in measuring distances on the floor. The movable arm BG is pivoted at B, which point is at a distance of one frame space from the scale DF. In case there are several spacings used, it is a simple matter to have a movable pin at B, with holes spaced as desired, in which to slip it. Great accuracy in this respect is not necessary. This arm BG supports on its movable end a sliding square with a scale about three inches long on its short leg with the zero end at the apex of the angle. The other leg should be not less than 8 inches long, both legs being beveled as shown for convenience in reading the scales. It will be noticed that the arm BG is made with an offset. This should be just enough so that a line through the edge of the scale bb_2 extended will pass through the point B. An offset is also made on the inner edge of the straight edge AB at E, which is the apex of the right angle BEF.

In comparing Fig. 7 with Fig. 6, it is seen that the arm BG in Fig. 8 takes the place of the line ab in Fig. 6, and that the movable square duplicates the conditions shown in the small triangle bb_1b_2.

The application of this instrument to the floor is not only accurate and easily done but it is quick and entirely does away with the more tedious methods formerly employed. To use, place the straight edge through the points B and D, Fig. 6, and read the curvature GF on the scale CD. The point of greatest curvature is usually the approximate center of the plate and this point is more easily and quickly found, if a series of distinguishing marks are spaced equidistantly on each side of C as shown. Now move the instrument so that the point E falls on the frame line, with DF perpendicular to it, and move the arm G out to the next frame. The

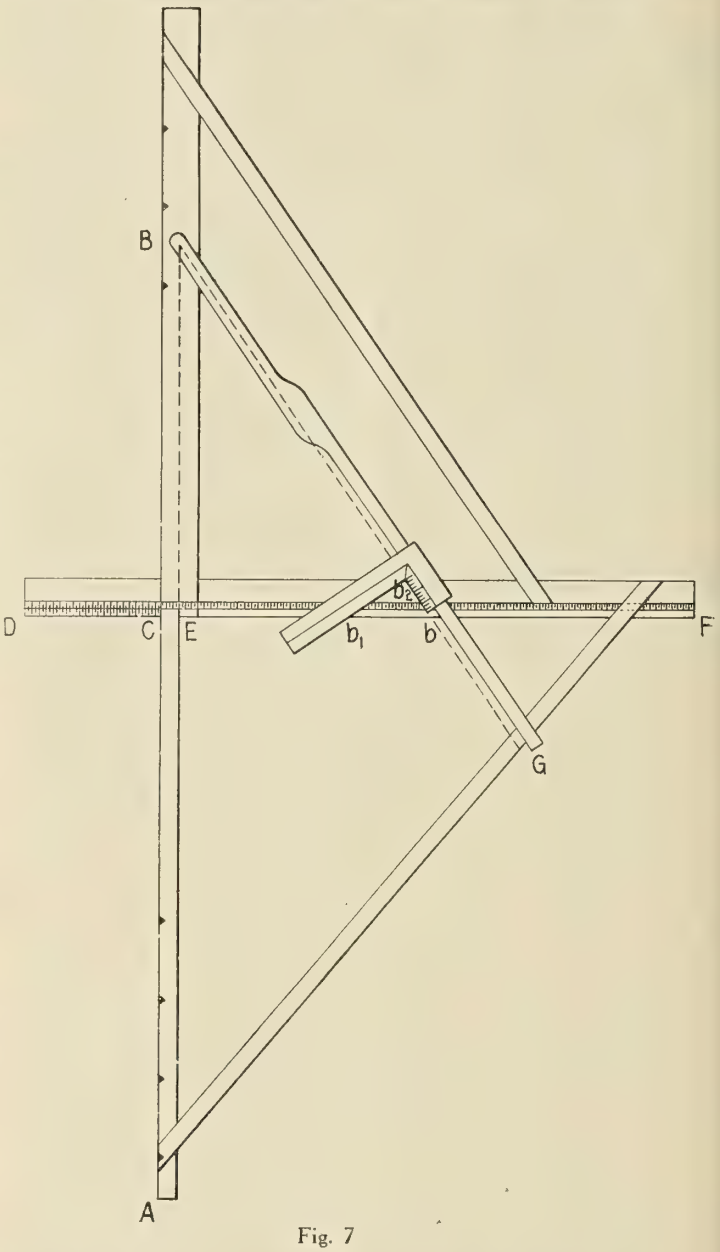


Fig. 7

angle EBG then represents the bevel of the frame at that point. Slip the small square along the arm until the reading bb_1 on the scale DF equals the amount of the curvature just read at GF, Fig. 6. The intercept on the scale, bb_2 will be the required curvature on the expanded plate.

Unless the curvature or the bevel of the frames is changing rapidly, it will be found necessary to take only each fifth frame. The difference can be divided evenly between the others. When a list of these measurements is made, the instrument is carried to the development work and the points spotted in by means of the straight edge and the scale CD. A batten bent through each group of three points gives the heel of frame—but be sure that the curve is in the right direction as previously directed.

(*To be continued.*)

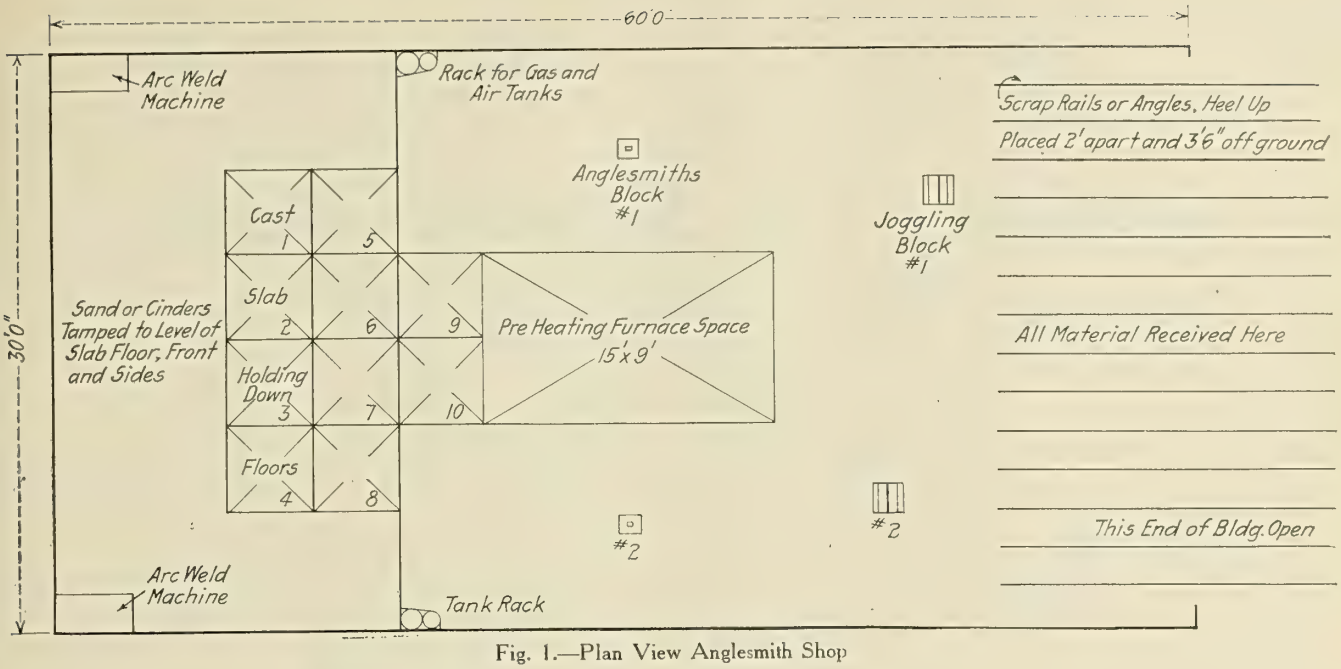


Fig. 1.—Plan View Anglesmith Shop

Modern Anglesmithing

Arrangement of Angle Shop—Typical Methods of Making Inside and Outside Bends by Means of Welding Apparatus

BY MAURICE NICHOLLS*

THE logical treatment of anglesmithing falls in two divisions: first, a shop and equipment section, and, second, a study of modern methods.

Fig. 1 shows the ground floor plan of a shop that will handle the angle work of five to eight vessels at one time. It should be noted that no old-fashioned coal burning angle forges are installed. The coal forge has faithfully served the shipbuilding industry since the day of the first iron ships, but now it must be set aside in favor of the speedier, cleaner and more modern devices, the most important of which are the electric arc, gas cutting and heating.

The building should be of light material, whitewashed on the inside. An ordinary tamped cinder floor answers the purpose very well. The building and equipment are arranged for a direct flow of material through progressive stages of fabrication, i. e., material is received at one end and the finished product turned out at the other, thus avoiding shuttling while in the shop.

Arrangement of Joggling Blocks

In view of the fact that many yards do not use angle joggling machines, the work naturally comes to the angle shop. The joggling blocks are arranged out of line so that two long bars may be handled at the same time. Gas and air tanks are located at either side to accommodate these blocks. These tanks are housed so that they may be replaced from outside the building when empty, thus eliminating lost time by carrying tanks around and over the work.

Next in line are the anglesmiths' blocks arranged one on either side and served by the gas tanks installed at the sides of the shop. It will be noted that there is a space allotted for a preheating furnace, which is to be used in connection with the welding of castings, as it avoids the use of charcoal and the construction of a temporary furnace. Castings may be returned to this furnace, which is then allowed to cool. The slow cooling of the castings in the furnace results in well annealed material. If this is not desired, good results in preheating can be obtained on the slab floor with charcoal, by placing an air connection under the slab.

The slab holding-down floors are provided for beveling small clips and parts of shoes that take the contour of the shell where this work is too heavy to be done by acetylene heating. At the sides and front of the slab gratings is a cinder floor level with the gratings, to be used for welding the cuts and filling-in pieces. This makes the best flooring for this type of work, as it prevents the metal from sticking during the welding process. Arc welding machines are located at this end of the building, one at either side.

The length of the building is spanned by two overhead cranes, the center of each being over the anglesmith blocks. Each crane is provided with a 4-ton hoist.

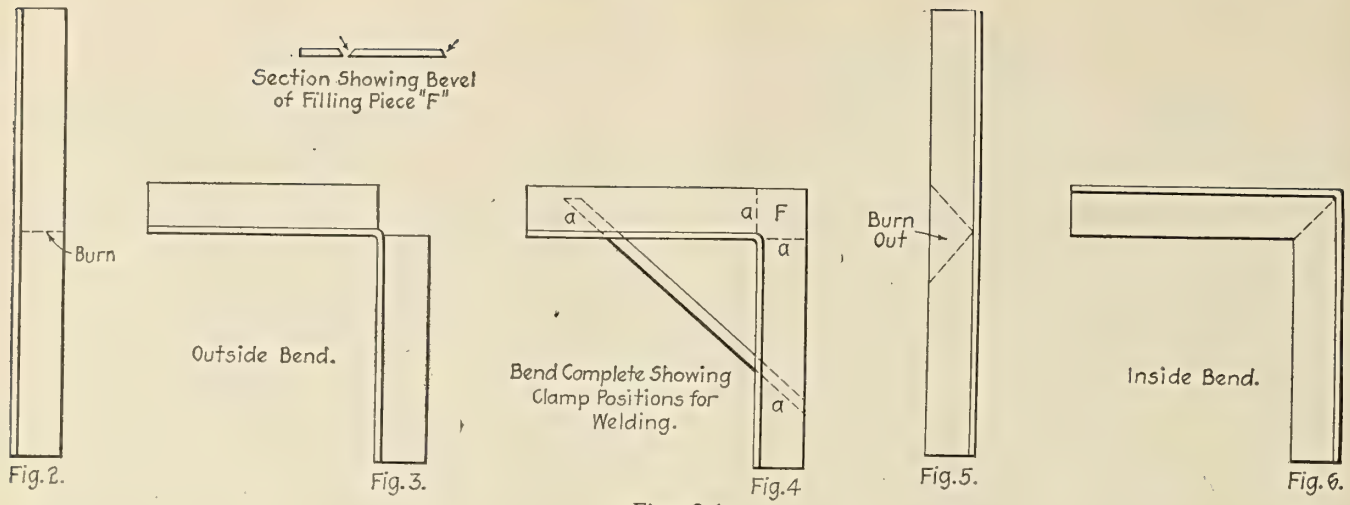
Welding Equipment

Any standard type of arc welding machine is suitable for the electric welding of angle work. There are so many different sorts of gas welding and burning outfits that no special make will be recommended. It is advisable, however, to have two complete sets of gas tanks, one to be connected to a burning torch and one to be connected to a heating and welding torch. This can be worked out with the desired combination, according to the work to be performed, and will save the time usually lost by changing tips.

Making an Outside Bend

As seen in Figs. 2 to 8, the general procedure for doing angle work with the aid of gas welding is exactly the same as for coke fire work. In the first operation of making a right angle outside bend, Fig. 2, the burning torch should be held at an angle and then reversed to the other side and worked back. This gives the cut a V-shape and requires only light chipping to clean it for welding. The angle is then placed on the anglesmith's block and heated as indicated for bending.

* Hull superintendent, McDougall-Duluth Shipbuilding Company, Duluth, Minn.



Figs. 2-6

It is interesting to note that angles up to 6 inches by 6 inches may be bent very easily through 90 degrees by heating a space not over 1½ inches in width. Fig. 3 shows the angle bent to shape.

After the bar has cooled, the filling piece is fitted and the angle is braced with a ¼-inch by 1-inch flat bar and clamped at position *a* (see Fig. 4). It is always advisable to brace bent work in this manner, as the heat developed by welding the filling pieces will throw the work out of line. The filling piece *F*, Fig. 4, is beveled as indicated, to meet the bevel on the angle. The bar can be unclamped after the work has set and the welds along the filling piece smoothed out.

For any square or rectangular bounding bar the same procedure is followed several times. The work can be laid out complete, and if two heaters are used it is a simple matter to make two bends at the same time on the slab floor.

Steps in Making an Inside Bend

Fig. 5 shows an angle laid out for an inside bend, and, as in the first case, the torch should be held on the two cuts, so as to form a V when the bend is complete. Bends of this sort should be braced as shown in Fig. 4. The variations of the inside and outside bend are too numerous to mention and the extent of their application is limited only by the ingenuity of the man in charge.

Figs. 7, 8 and 9 show various stages in the construction of a sump well, bilge well, or drain pot, as it is variously called. The welded job is not only lighter than a casting, but is made at a third the expense and with a considerable saving in weight. Welds made by gas heating and bending are completed in about the same time as required to make the pattern for a casting. It is never necessary to heat the line of bend more than 1½ inches in width. Table I shows the approximate time required to make up angles by welding and the estimated time under the old way:

TABLE I

Size Angle, Inches	Time, Minutes	Time with Old Method, Minutes
Outside Bend		
3 by 3	3	10
4 by 3	4	15
5 by 5	5	20
6 by 6	8	28
Inside Bend		
3 by 3	3.5	13
4 by 3	4.5	13
5 by 5	7.0	24
6 by 6	9.5	33

The data given in Table I are not for light weight or heavy angles in the above sizes, but are averages taken from numerous lists of various weights.

All of the filling pieces are arc welded. The superiority of the arc weld over the torch cannot be disputed in this line of work.

The number of men necessary to do this work is the same as when coke fires were used, namely, the anglesmith and two strikers or helpers. Three helpers are necessary where long bars are to be worked. At least one, and preferably both, of the strikers should be second class burners. From actual

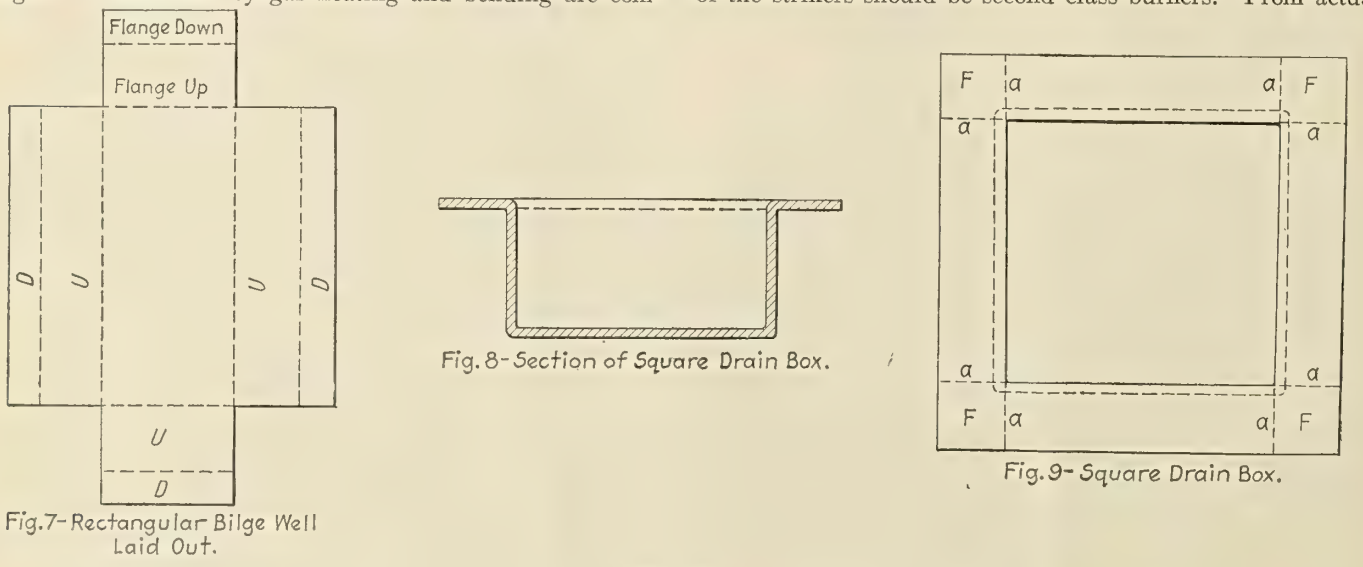


Fig. 7-Rectangular Bilge Well Laid Out.

Fig. 8-Section of Square Drain Box.

Fig. 9-Square Drain Box.

Figs. 7-9

experience, two crews of this sort were able to keep ahead of a five-vessel (3,500-ton type) construction programme. In fact, two crews were only used for part of the time. For arc welding the filling pieces, two machines are provided. One machine is sufficient to keep up the work completed by the anglesmith; the other is intended primarily for welding skylights, light tanks, ladders, etc., which are assembled close to the angle shop.

Random Notes by an Old Seaman

The Shape of a Vessel's Stern and Design of the After Body—Rudders and Rudder Design

BY CAPTAIN R. E. BARRY

SOME twenty years ago Mr. Worthly designed for Alfred Holt some 8,000-ton steamers with a new type of stern. Forgings were eliminated except for the upper part of the rudder stock and about ten tons in weight saved (see Fig. 1).

This form of stern soon became popular, although the builders forgot the reason of its design and fitted heavy forged stern frames. Even today the same general outline is seen on many of the large twin screw vessels.

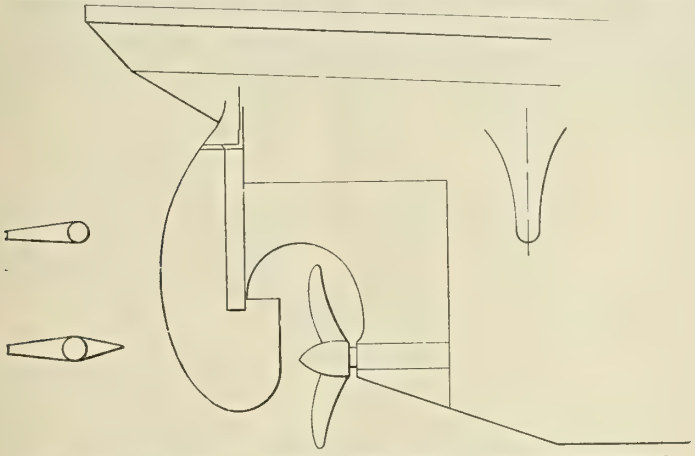


Fig. 1.—Special Type of Stern With Heavy Forgings Eliminated

In Figs. 2 and 3 are shown sterns of type vessels built for two large steamship companies. Figs. 4 and 5 show typical endings of sailing vessels—Fig. 4 a noted square rigger and Fig. 5 a large schooner.

The type shown in Fig. 3 steers very badly, the wake is sinuous, varying from two points on one quarter to two on the other. This ship will not steer under six knots at all if the screws are stopped, and indifferently if moving. It is customary for her to come up the bay relying on twin screws for steering with the helm amidships. Fig. 2 steers a little better. Fig. 4, when loaded, steers remarkably well with very little helm being needed at any time. Fig. 5 is typical of a number of very large wooden schooners and steers well loaded or light.

The Cut Away Stern

It is probable that the cut away stern on merchant vessels is a reflection of the naval practice in this matter, but the requirements of the two services are radically different. The naval vessel must have a small tactical diameter for maneuvering purposes, while the merchant vessel should steer as straight a course as possible. The initial moment about the pivoting point on the naval vessel when the deadwood is much cut away cannot compare with that of the narrow rudder of the old type sailing ship, but when once started it will swing much faster and pivot on a point much farther forward.

Rudders

Many tests have been made at tanks on the pressures on rudders and on the location of center of pressure, but most of these tests have been independent of the hull. While this system gives formulae for torque, etc., it is almost useless as a measure of steering qualities of a ship.

The narrow thick rudder on the sailing vessel would steer when the way on a vessel was imperceptible and only small angles of helm were ordinarily used. But in the modern cut away stern steamer the steering engine is in almost constant motion and the excessive helm is noted in the engine room by the reduction in revolutions of the main engines.

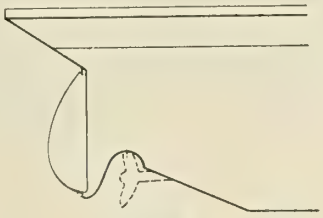


Fig. 2

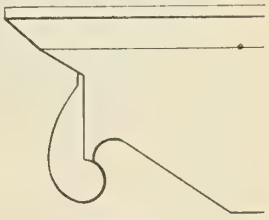


Fig. 3

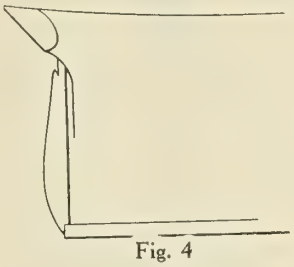


Fig. 4

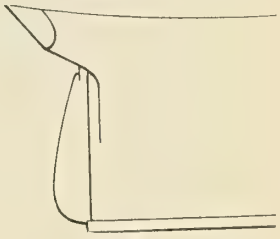


Fig. 5

Single screw steamers with large screw apertures (many of the old American boats had an aperture reaching to the tuck line) would pay no attention to the helm when the machinery was stopped, swinging all around the compass despite the attempt to maneuver the vessel under sail.

All of which leads to the conclusion that the steering of a vessel depends less on the actual transverse pressure on the rudder than on the lateral pressure of the mass of water banked up along the run forward of the rudder. Figs. 6 and 7 show the conditions in the two types. Fig. 6 would steer when way was imperceptible and Fig. 7 not under five knots.

Fig. 6

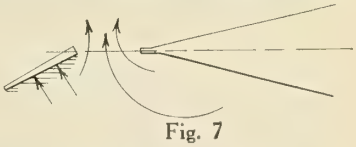


Fig. 7

A case which proved this absolutely was a French cruiser with a balanced rudder as shown in Figs. 8 and 9. Here the vessel's head went to the same side as the helm was forced, showing that the banked up pressure on the side was greater than on the rudder. When the balance was cut off the rudder and the aperture plated up, the vessels steered very satisfactorily.

With naval vessels economy is not a paramount matter and it is necessarily sacrificed to maneuvering ability, but in the

merchant service, with the sharp competition which we may expect in the near future, it behooves us to build vessels that will not increase the distances steamed by sinuous courses or throw extra work on the main engines by constantly blocking the screw race with the rudder, to say nothing of the energy consumed by the steering gear.

Late vessels of the Anchor Line and of the Union Castle

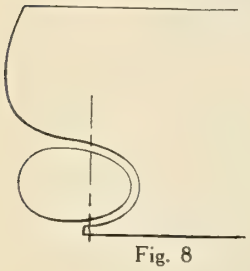


Fig. 8

Fig. 9

Line have the solid deadwood with no aperture whatever and consequently will steer well.

Rudder Design

It often seems as if well-known truths are forgotten in a maze of technical calculations, and the type of rudders fitted to many of our recent single screw steamers exemplify this. In the old days it was a matter of experience that the whirling water of the race had more effect on the lower half of the rudder than on the upper half. Therefore, all rudders of single screw steamers were designed with the center of lateral resistance well above the center of the propeller.

The pear-shaped type will allow the helm to be carried amidships on a straight course, while the rectangular type as recently fitted will require four or five degrees of helm all the time; that is, the lower part of rudder must swing with the lower half of race whirl.

But sometimes one sees the pear-shaped rudder on a twin screw vessel. Here it is not nearly as efficient as the rec-

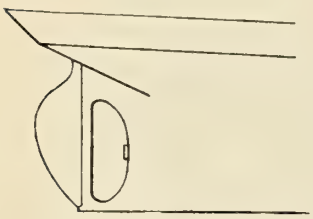


Fig. 10

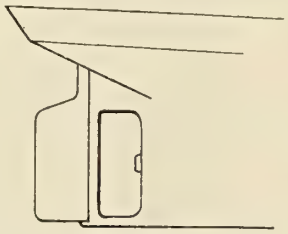


Fig. 11

tangular rudder, especially with out-turning propellers, and merely gives more surface for wave action.

Design of the After End of Hulls

In the design of the after end of hulls there has been a tendency towards very fine waterlines below with full load lines, giving a pronounced V-section, which not only makes stowage aft difficult, but greatly reduces the lateral resistance to distortion. One large single screw steamer of this type on the Pacific coast broke four shafts at short intervals after being put in service. She was excessively fine in the run. Finally a flexible coupling was fitted forward of the tail shaft and there has been no trouble since.

One model recently tested with a pronounced U-section aft gave less resistance than an equal displacement model with the V-section.

Some vessels have been built so fine aft that each plate had to be riveted up in turn as it was put in place, because if bolted up complete there would be no access to the rivet heads. Again, as it is impossible to clean in these narrow spaces, it is customary to fill with cement. Why carry useless weight?

In one China trader the after hold was so much V-shaped that a platform was built about five feet above the keelson.

A few years ago a fad to cut away the fore foot was carried to extremes. Admiral Taylor proved that the U-section forward was desirable for speed and uses it even in battleships where a few years ago they were much cut away for maneuvering purposes.

Another little point and I have done. Many mail boats today with high freeboard have little sheer and often two or three tiers of deck houses aft. The result in a beam wind is that they carry weather helm due to the center of effort being so far aft. If a forecastle head had balanced the after houses they would need less helm, so waste less energy. Also in many shelter deck type steamers the bow is so low that in any sea it is dangerous to go forward. A short forecastle head would have made them much more comfortable.

Foreign Trade With Colombia

COLOMBIA has been enjoying a remarkable period of prosperity the last three or four years, based largely upon her exceptional coffee crops. These have averaged considerably more than 1,000,000 sacks annually, and last year reached the unprecedented figure of 1,500,000 sacks. In the American markets it has commanded a constantly advancing price.

Development is also being made of her coal and oil fields and her iron industry is already fairly well established. Particular attention is being given the manufacture of agricultural and mining machinery, but by reason of the inexperience of the labor obtainable there is still an excellent opportunity for American competition in these lines, the standard of the local product not being the highest.

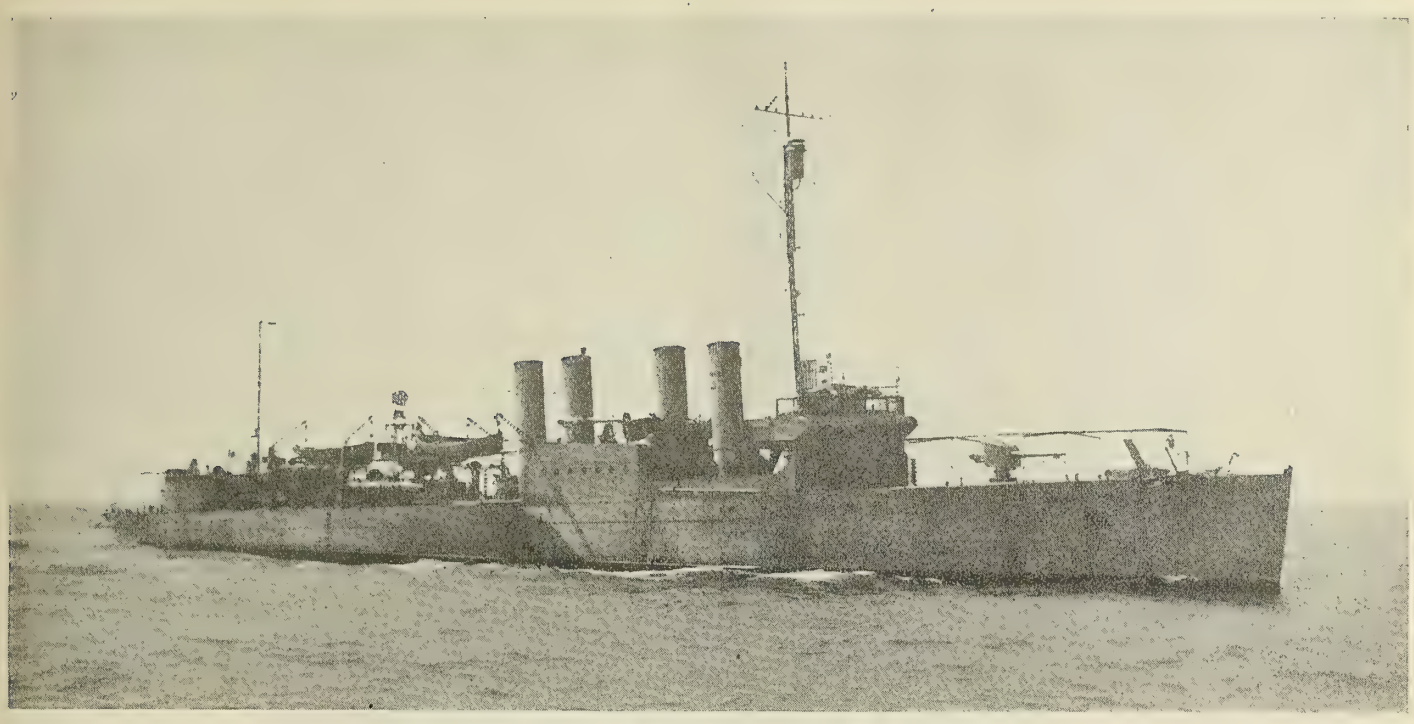
America profited principally through the war period interruption of foreign supplies. The armistice saw the warehouses of Medellin, the trading center of the country, utterly depleted of European goods. Enterprising American firms had made the most of the opportunity, and with the close and friendly relations established will doubtless be able to retain the advantage they have gained.

Just how completely American exports have dominated the Medellin markets the last two years is emphasized in a statement recently issued by the United States Department of Commerce showing that of wide range of imports the United States had supplied the following percentages:

Textiles	60	Typewriters	100
Hardware	100	Musical instruments	100
Steel products	100	Hats (felt)	40
Chemicals	100	Men's wear	90
Medicines	90	Women's fancy wear	75
Paper products	100	Toilet articles	80
Machinery	100	Shoes	100
Kitchenware	100	Jewelry	40
Tools, etc.	100	China dishes	100
Dyes	100		

One of the important influences to this end was the establishment of branches in Colombia by several leading banking institutions of the East. Through these the transaction of business has been greatly expedited and the mutual friendship and understanding of the contracting parties materially increased. Lack of similar adequate banking facilities is one of our greatest handicaps in others of the Latin American group of countries.

Marine Electrical Engineering.—A joint meeting of the Metropolitan section of the American Society of Mechanical Engineers and the New York section of the American Institute of Electrical Engineers was held in New York on January 28, to discuss the subject of marine electrical engineering. Papers were read on electric ship propulsion, electricity applied to ship auxiliaries and electrical terminal facilities.



United States Torpedo Boat Destroyer of the *Kane* Type

American Destroyer Hits Mine in the Baltic

After End of Ship Bent Bodily to Starboard—Damage Chiefly Above Waterline—Vessel Towed to Repair Yard

BY COMMANDER E. S. LAND, C. C., U. S. N.*

THAT peace has its naval difficulties as well as war is typified by the accident to the U. S. S. *Kane*, on October 1, 1920, when this American destroyer hit a floating mine in the Baltic just outside the Gulf of Riga. The *Kane* was well clear of the mine fields and no difficulties with regard to mines were expected, although an extremely careful watch was kept, as is customary in these waters. Fortunately, there were no casualties to the personnel, although the violence of the explosion caused minor injuries to three of the crew as they were hurled against bulkheads and stanchions.

The remarkable part of the damage to the *Kane,* is that most of the force of the explosion took effect at and above the waterline. To attempt to follow out the relations of cause and effect in a mine explosion is a good deal like deciphering Egyptian hieroglyphics. In this connection, attention is particularly invited to the damage to the 4-inch gun mount.

Principal Dimensions of the Vessel

The *Kane* is 314 feet long overall, with 176 frames spaced 21 inches apart. Her beam is 39 feet 10½ inches; draft, 9 feet 4 inches; and her full load displacement, 1,300 tons.

The explosion occurred off the port quarter. There is strong circumstantial evidence that one of the port propeller blades struck a mine floating just below the surface, as the leading edge of the blade was crushed to a depth of from ¼ to ½ inch, for a distance of 14 to 18 inches.

The after end of the ship was apparently bent bodily to starboard, bending showing up throughout the girth of the ship from frames 141 to 143, i. e., about 65 feet from the stern of the vessel. This bending included, to a greater or less degree, both lines of shafting, particularly the port shafting, as the port engine could be turned over only with much chattering of the gears and heavy vibration of the ship. The starboard engine could be turned over up to one hundred revolutions per minute, but this caused considerable chattering of the gears and very marked vibration of the ship. This springing of the shafts occurred in the tail shafts; the port stern shaft (the section of the shaft just forward of the tail shaft) was bent.

The bearings and couplings connecting the engine shaft and stern shaft were not damaged. The steering gear and rudder were first thought to be badly damaged, but afterwards found to function reasonably satisfactorily. The main and auxiliary machinery were not damaged to any appreciable extent.

Structural Damage

The main deck starboard stringer was buckled to a depth of four inches between frames 141 and 142; the stringer angle was broken between frames 141 and 142; the buckling was carried across the deck between frames 142 and 143; the main deck stringer plate, on the port side, was buckled at frame 142, the depth of the buckle on the port side was about 2½ inches. The starboard stringer plate was torn for about 2 inches at the outboard edge and one rivet was gone. This was the only tear in the plating.

The starboard side plating was buckled at the top strake between frames 141 and 142, running diagonally aft to 143 on the waterline. The frames, brackets, and bounding bars were buckled and bent inboard of the buckled plating from the main deck to the garboard strake. One air port lens was broken and its frame distorted. The deck plating adjoining the port stringer plate had hair cracks in it; otherwise

*Naval Attaché, American Embassy, London.

there were no cracks or holes in any of the deck plating.

The side plating on the port side had a buckle about 1½ inches deep in the top strake of the plating between frames 142 and 143; the two top strakes were also badly buckled from frame 165 to 172, the third strake of plating from the top was slightly buckled. The stringer plate on top was bent and buckled slightly, from frames 165 to 172. This buckling between frames 141 and 143 occurred in the decks and steel structure inside the ship as well as in the side plating and top side.

Propeller Guards

Three after sections of the port propeller guard were gone and two forward sections were damaged. The second strake of plating from the main deck was slightly buckled over the port strut.

Crew Space

Compartment D-204 on the first platform deck was buckled all the way across just forward of frame 142, to a depth of about 3 inches. There were small buckles at frame 144 on the starboard side only.

Magazines

Compartment D-108-M sprung a small leak on the port side between frames 141 and 142 directly under the shaft. The bulkhead between D-107-M and D-108-M buckled between frames 141 and 142. Compartment D-107-M sprung a leak between frames 141 and 142, directly under the shaft as well as in the garboard strake on the starboard side between frames 141 and 142; this strake was buckled slightly to a depth of from 1 to 2 inches. Compartment D-109-M had its side plating badly buckled between frames 143 and 144; a small hole was torn in the side plating abreast of the shafting between frames 143 and 144; the longitudinal was buckled. This leak was stopped by means of a life preserver wedged in.

Storerooms

Compartments D-105 and D-106 had the spring bearings sprung on both port and starboard sides and were leaking badly at first, but the leaks were stopped by setting up on the glands. Compartment D-110 had slight leaks at the seams abreast the port shafts at frames 146 and 147. The plating on the port side of compartment D-111 was buckled from frames 159 to 161. The stanchion in this compartment was driven down slightly, although it was not buckled. The web plating, brackets, and longitudinal were buckled from frames 158 to 164 on the port side. The starboard side was O. K. The middle line frames 162 and 163, and the web brackets buckled on the port side. The peak tank, bulkhead 164 was buckled and leaked slightly at the top of the vertical keel. This leak was calked.

Steering Gear

In compartment D-208, frames 164 to 172, the longitudinal and side plating were buckled. The knee brackets to the main deck were buckled and the rivets sheared, particularly at frames 168, 169, 170 and 171 on the port side. The diagonal stanchion brace on the port side at frame 168 was driven through the main deck, and the stanchion at frame 170 on the port side dropped out. The galvanized rack for oil cans on the port side of this compartment was blown adrift. A number of scattered rivets in the frames and longitudinal (fourteen in all) were sheared between frames 168 and 172. The starboard side of this compartment was O. K. The peak tank on the port side, plating, frames and partial bulkheads were all slightly buckled or bent from frames 164 to 175. A number of leaky seams were found here.

One life line stanchion and all life lines on the port side aft were blown away. The flagstaff, steering room ventilator and one 50-gallon steel drum full of gasoline were blown overboard.

Damage to Gun Mount

No. 4, 5-inch, 51 caliber gun was not injured. The gun carriage was spread apart about three-quarters of an inch at the extreme end of the trunnions; this left the gun resting o nthe lower cap squares of the carriage. The upper cap was not injured, but the left one was raised and split, thereby stripping the holding down bolts which secured both squares. The roller path of the training gear was damaged to such an extent that the gun could not be trained through more than six degrees. This was caused by the gun carriage and slide being driven aft, while the inside mount remained stationary. This caused the after guide lug with its holding down bolts to be broken off. The firing circuit of the gun leading from the transfer switch to the firing key, then to the pin, then to the bolts and screws holding the firing circuit was torn loose.

The tompion was in place when the explosion occurred, which complicated any efforts to explain these damages.

Propeller Struts Broken

Both port propeller struts were broken, the lower one being broken at the outboard end and cracked on the inboard end. The upper starboard propeller strut was broken.

Both tails shafts were sprung and the port stern shaft was bent. Practically the complete girth of the ship except the keel was buckled at about frame 142. The stern was bent 1 inch to the starboard, commencing at frame 141.

The main keel was not damaged.

Every effort was made by the officers and men to bring the *Kane* from the scene of the explosion to Copenhagen in the most satisfactory condition practicable. The vessel was towed to Libau and from Libau to Copenhagen by the United States destroyer *Brooks*. There was considerable working of the stern of the *Kane* during this voyage, which was relieved to some extent, by fore and aft shoring across the buckled portion of the ship. On October 7, the *Kane* was docked at Landskrona, Sweden, and repairs immediately undertaken.

Weight Allowances

Crew and effects.—Allow about 1 ton per 10 men.

Passengers.—Allow 1 ton for every 15 persons in ordinary cases.

Passengers.—Allow 1 ton for every 20 persons in excursion crowds.

Baggage.—Allow 1 ton for every 250 persons in excursion crowds.

Baggage.—Allow 1 ton for every 10 persons in long voyages.

Fresh water.—Allow 1 ton per day for every 60 first or second class passengers.

Fresh water.—Allow 1 ton per day for every 300 third class and steerage passengers.

Salt water for sanitary purposes.—Allow from ½ to 5 tons, according to extent of sanitary accommodations.

Provisions.—Allow 1 ton per day for every 100 first and second class passengers.

Provisions.—Allow 1 ton per day for every 450 third class and steerage passengers.

Bedding, napery, cutlery, crockery, glass, silverware.—Allow 1 ton for every 30 persons on board.

Lake Plan of Vessel Salvage.—Simon Lake, inventor of the Lake type of submarine, is experimenting with a new method of raising sunken vessels by injecting into the hull by means of centrifugal pumps small blocks of balsa wood, the buoyancy of which is expected to raise the vessel.

Fig. 1.—S. S. *Robin Gray*, Express Freighter of 10,400 Tons Deadweight, Built by Skinner & Eddy Corporation, Seattle, Wash., and Fitted With General Electric 3,000-Horsepower Geared Turbines of the 2-Plane, Double Reduction Type. Speed of Vessel Loaded 11.5 Knots

The General Electric Marine Geared Turbine

BY C. H. PEABODY, DR. ENG.

The real problem of the application of the steam turbine to marine propulsion comes from the fact that the steam turbine is essentially a high speed machine while the propeller must have a good diameter and must run slowly. The General Electric Company offers a complete solution of this problem; for large ships they offer the electric drive and for small and medium sized ships they offer the double geared steam turbine. This article presents the latter.

FIG. 1 shows a recent application of the General Electric Company's turbine to the S. S. *Robin Gray* and *Robin Goodfellow*. These sister ships have 10,400 deadweight tons capacity, 3,000 horsepower and 11.5 knots speed loaded. Fig. 2 shows the engine room of these steamers.

The most characteristic illustration of the turbine and gears is given by Fig. 3, showing the upper half of the casings removed and the turbine rotor and gears in place. The turbine complete is shown by Fig. 5. These illustrations show that the turbines and gear form a completely self-contained unit that, if need be, may be manufactured, erected, adjusted and tested at the company's works, may be shipped intact and delivered in the engine room of the ship ready to connect to the steam main and the propeller shaft. A notable feature is the rigidity of the casing that needs only to be bolted down to the engine foundation as shown by Fig. 5.

The Turbine

The steam turbine is of the same type as that supplied by the General Electric Company to power and electric stations and it runs with the same regularity and efficiency. The construction of the turbine is shown by Fig. 4. There are five stages for the regular turbine used in forward gear and two stages for the backing turbine. The first stage for both forward and backing turbines has two velocity stages; all other stages are single pressure stages. The steam enters the steam chest as shown by the arrow at the right (Fig. 4) and expands in a series of nozzles and then passes the first set of blades of the wheel, is reversed by stationary guides and passes through the second set of blades. The advantage of this arrangement is that the steam is reduced in pressure and temperature before it enters the turbine casing. From the first stage the steam passes to the second set of nozzles in the first diaphragm and then through the second wheel and then in succession through the remaining stages to the exhaust, which is very liberal indeed.

Astern Turbine

The backing turbine is essentially a high pressure turbine, compact and powerful. There is always sufficient steam available when backing, so that economy is unimportant. The backing turbine when idle runs in a good vacuum with correspondingly small resistance.

The Curtis turbine expands the steam in any set of nozzles

Fig. 2.—Engine Room of S. S. *Robin Gray*, Showing Operating Side of Turbine

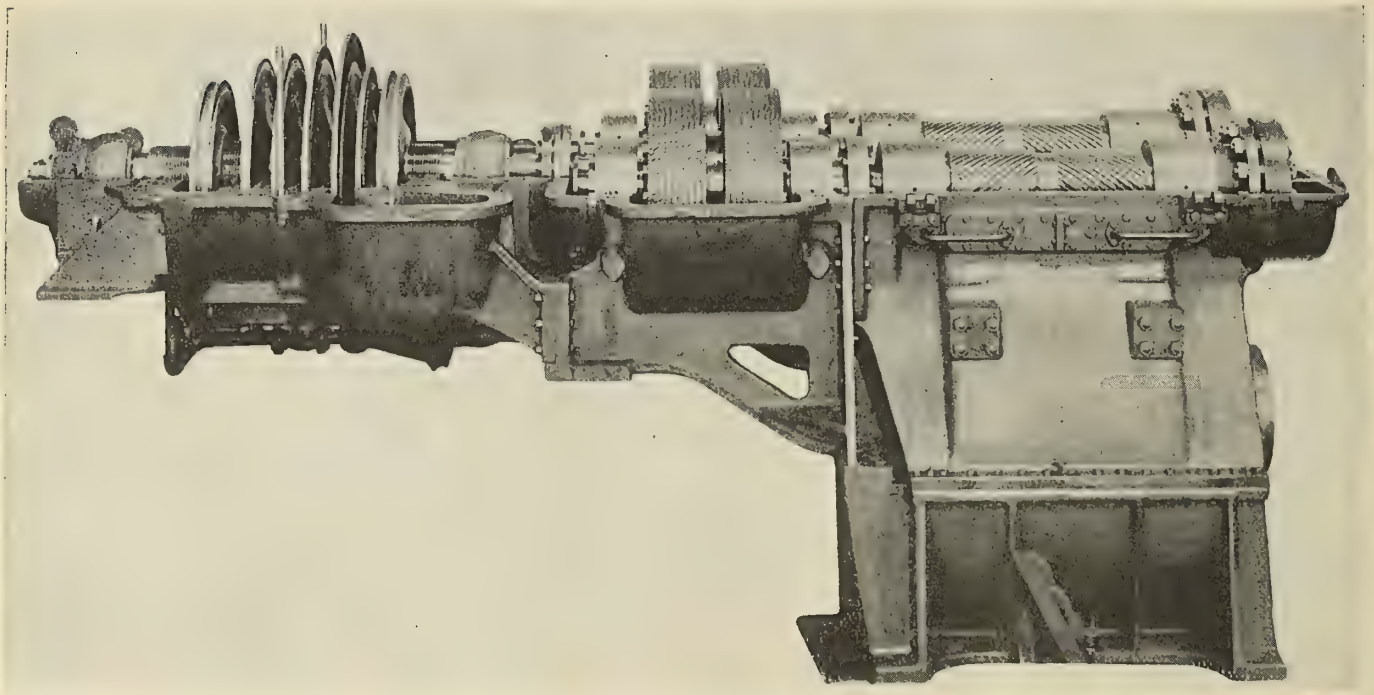


Fig. 3.—Two-Plane Type Marine Geared Turbine—Port, Looking Inboard—Upper Halves of Castings Removed, Showing Turbine Rotor and Gears in Place

THE GENERAL ELECTRIC MARINE GEARED TURBINE

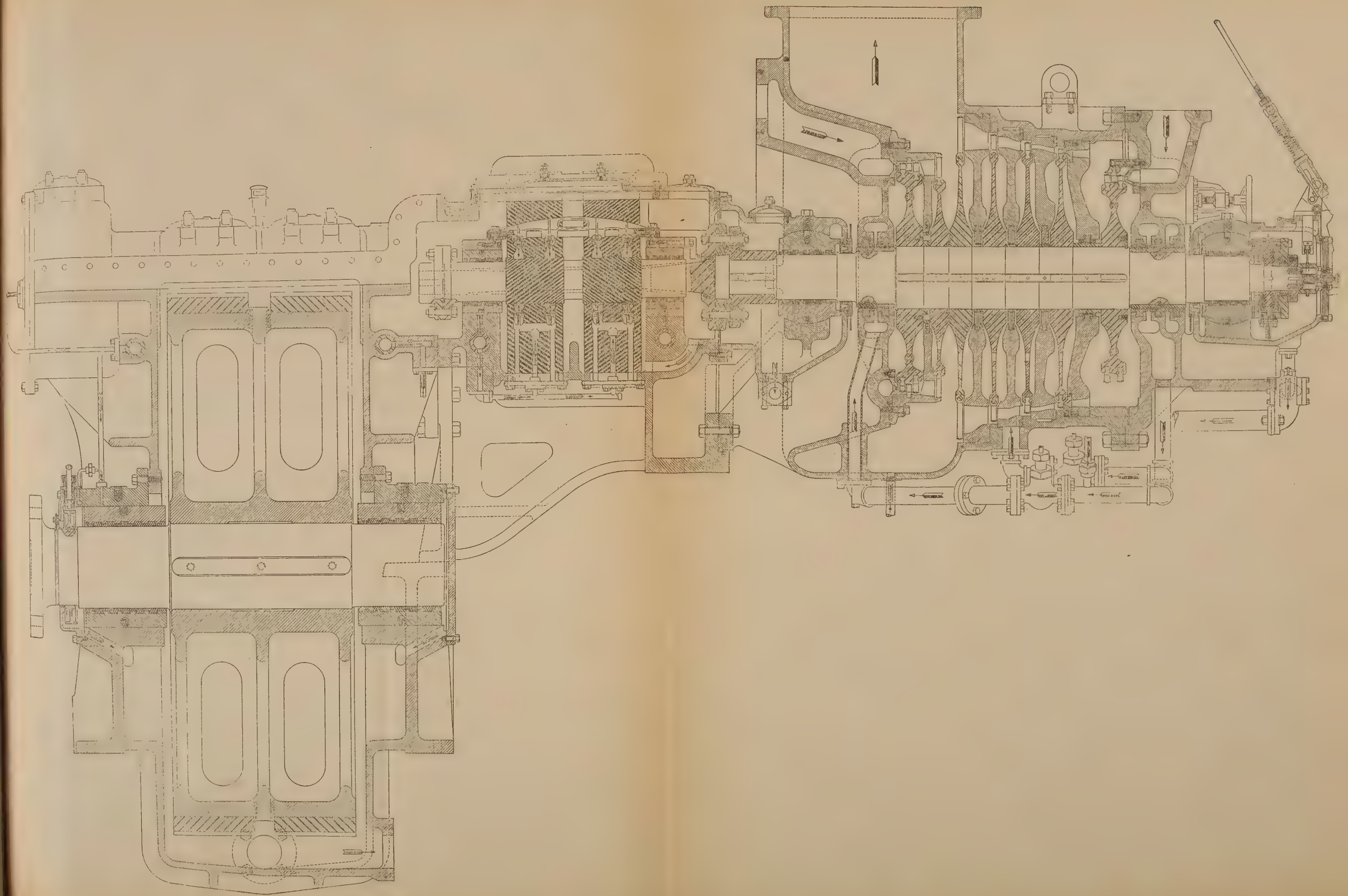


Fig. 4.—Assembly of 2-Plane, Double Reduction Type Marine Geared Turbine—Vertical Section Through Center of Turbine and Gears

Fig. 5.—Two-Plane Type Marine Geared Turbine—Starboard, Looking Inboard—Showing Operating Side

down to the pressure of the chamber in which the corresponding wheel runs. The pressure is practically the same throughout any given chamber, and, consequently, there is no tendency for the steam to pass around the ends of the blades. A shrouding over the ends of the blades steadies them and confines the flow of steam. An important consequence is that both radial and axial clearances may be liberal and there is no risk of stripping the blades. Another consequence is that there is little, if any, end thrust on the turbine; however, an efficient step bearing is shown on the right hand of the turbine shaft to take care of any thrust that may occur and to adjust and maintain the shaft in its correct place. The blades are drop forged of manganese bronze and are especially strong at the roots, where they are machined to fit the edges of the wheels as shown by Fig. 6. The shorter blades are dovetailed to fit in a groove, but the longer ones have a dovetailed slot and straddle the edge of the wheel.

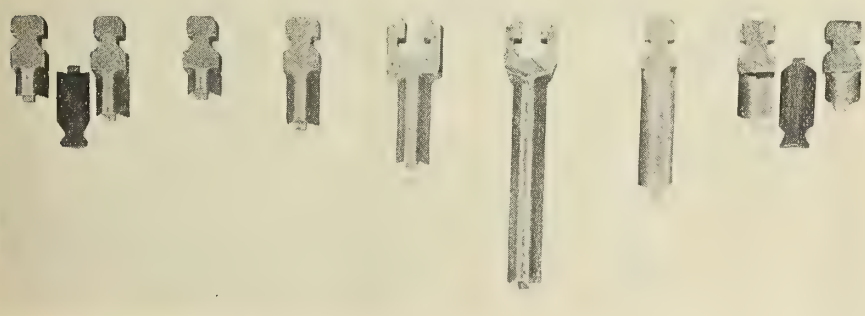


Fig. 6.—Buckets for Marine Geared Turbines

Leakage through the glands in the casing where the turbine shaft passes through is checked by labyrinth packings as shown on Fig. 4. There is another labyrinth packing between the first and second stages. The packings in diaphragms between other stages, where the fall in pressure is less, are simpler in form, but work on the same principle. The labyrinth packing at the high pressure end of the shaft is double. The leakage from the first stage of the packing is piped over to supply low pressure packing at the other end of the shaft; the outer stage is piped to a lower stage of the turbine.

Turbine Wheels and Casing

The turbine wheels are turned from solid steel forgings and pressed onto the shaft as shown by Fig. 7. This illustration shows also the bronze sleeves carrying the running rings of the labyrinth packings and the flange which delivers the power to the gearing. The casing is parted horizontally through the axis of the shaft, and the diaphragms are made in halves set in the upper and lower parts of the casing. The turbine can be opened by lifting the upper part of the casing as shown by Fig. 8, which shows one of the guide pins in place.

Steam to the turbines passes through an emergency valve with a tripping device for rapidly shutting off steam in case the speed increases dangerously or for any other reason; then the steam passes through the maneuvering valve, by which it is directed to either the forward or backing turbine. In addition there are two hand valves for controlling the pressure on the first set of

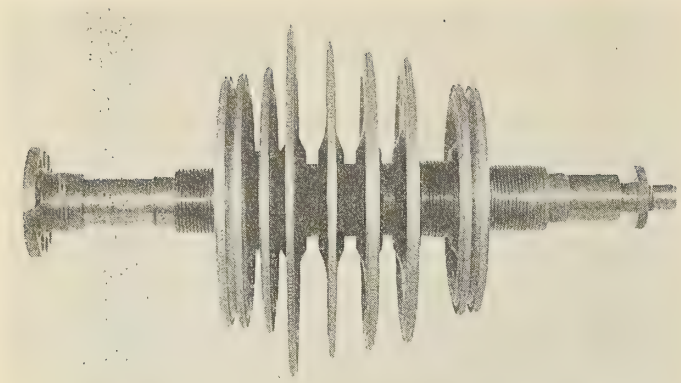


Fig. 7.—Turbine Rotor

nozzles when the ship is running slowly in stormy weather or for any other reason.

The Gearing

The outstanding feature of the power unit as shown by Fig. 5 is that the gearing is larger and heavier than the steam turbine, and yet the unit is compact and the engine room is conveniently arranged as shown by Fig. 2. The reason is that the steam turbine has come to its normal condition and is a small high speed motor, making 3,000 revolutions per minute. The propeller makes 100 revolutions per minute and has desirable diameter and pitch ratio. The two pinions, as shown by Figs. 9 and 10, are made of hollow forged high carbon heat treated steel. The two gears have cast iron hubs, but the teeth are cut in heat treated forged steel tires which are shrunk on the hubs (see Figs. 11 and 12). The teeth of both sets of gears have a helical angle of 35 degrees; the high speed set are 4 pitch and the low speed are 2½ pitch. The teeth have involute outlines, as shown by Figs. 13 and 14; all high speed gears are involute gears because they can be cut with extreme accuracy and because they engage correctly even though the distance between the axis of the gears differs from the designed distance.

Perhaps the most interesting feature of this turbine arrangement is the provision for free running of each individual element of the gear. Of course, the turbine rotor is balanced by the usual certain and precise methods used for parts having high rotative speed. In addition, the shaft bearings, as shown by Fig. 4, are carried by blocks with a spherical form, so that to some extent the shaft may find its own alinement. The turbine shaft, as shown by Fig. 9, is connected to the far end of the high speed pinion by an internal shaft of small diameter. This internal shaft is coupled to the turbine shaft by pins which give a slight freedom or play between the flanges on these shafts; consequently, the pinion is free to run in its own bearing and to seek the slight end adjustment necessary to ensure equality of bearing for the two helical sets of teeth. Since all parts are machined and fitted with the extreme precision of high grade modern machine work, a very slight degree of movement is all that is necessary for free running.

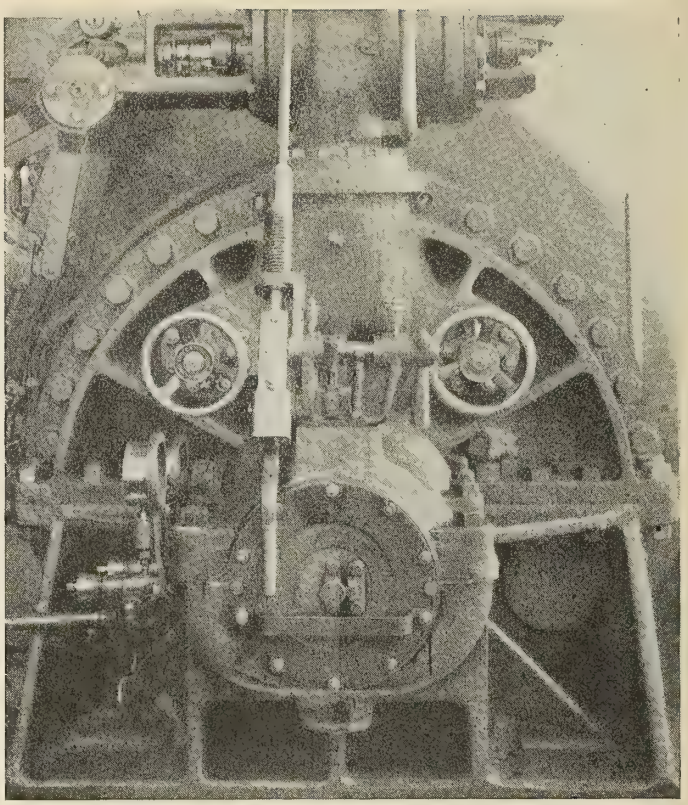


Fig. 8.—Marine Geared Turbine Forward-End View, Showing Hand Valves, Clearance Indicator and Emergency Tripping Devices

The same device is used to secure freedom between the high speed gear and the low speed pinion. The pin device is placed at the far end of this pinion for convenience in construction. It will be noticed that the holes in the flanges for both high speed and low speed couplings are bushed and that the low speed pins have sleeves. The full floating bushing around the low speed pins allows an equal distribution of load, and provides a positive method for checking the alinement during and after installation; replacement, when wear occurs, is easy and cheap.

The low speed gear is on the propeller shaft and is main-

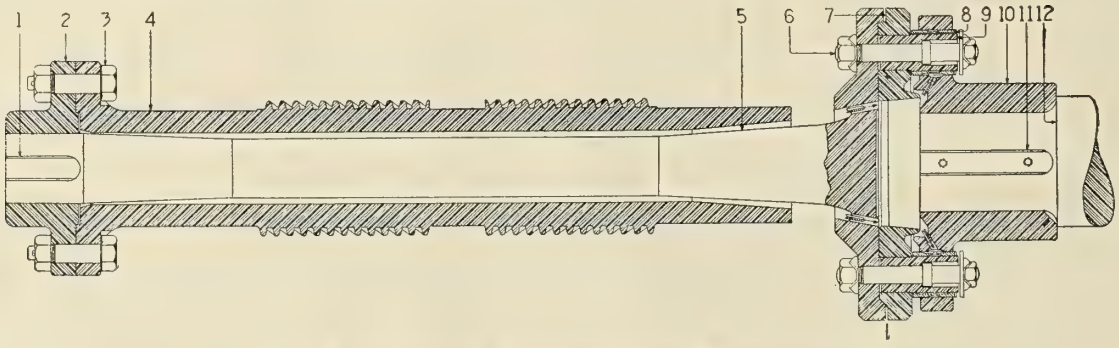


Fig. 9.—Assembly of High-Speed Pinion With Couplings

1 Key for 2 and 5
2 Flanged coupling for 5
3 Body bound coupling bolt with nut and cotter for 2 and 4
4 Hollow or quill-type pinion
5 Flexible shaft with coupling flange
6 Bolt with nuts, locking plates, and washer for 5, 7 and 10
7 Coupling flange—male half
8 Bushing
9 Coupling pin
10 Flanged coupling for 12—female half
11 Key for 10 and 12
12 Turbine shaft

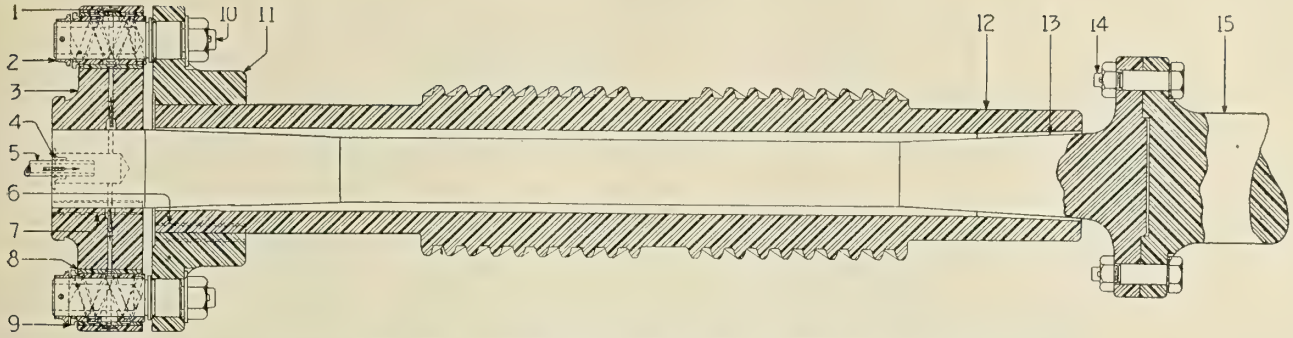


Fig. 10.—Assembly of Low Speed Pinion With Couplings

1 Locking screw
2 Retaining ring
3 Coupling half for 13
4 Bushing
5 Pipe
6 Key for 11 and 12
7 Key for 3 and 13
8 Bushing
9 Sleeve
10 Coupling pin with washer, nut, and cotters for 3 and 11
11 Coupling half for 12
12 Hollow or quill-type pinion
13 Flexible shaft with coupling flange
14 Body bound coupling bolt with nut and cotter for 13 and 15
15 High-speed gear shaft with coupling flange

tained in its position by the propeller thrust bearing, which must consequently be set and watched with care, because the freedom of the pinion, while sufficient when the gear is in adjustment, is, after all, very small in absolute movement. The upper half of the gear casings can easily be raised, exposing the gears and the bearings of their shafts. In addition there are flaps that can be raised for ready inspection.

Lubrication

The gears and all the bearings are lubricated continuously and liberally with oil that is filtered and cooled systematically, each part having its own supply under ready inspection. Any failure to maintain proper lubrication with cool, clean oil will lead immediately to deterioration and may cause extensive damage.

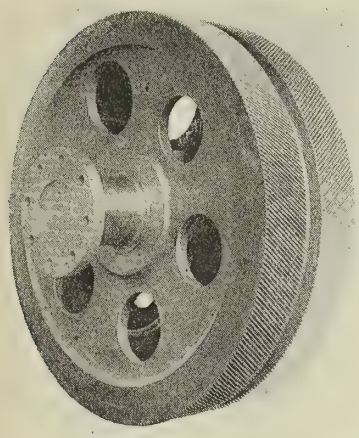


Fig. 11.—High Speed Gear

Since there is no wear on the turbine save that of the steam on the blades, and since the wear on gears and bearings is very slow, if proper provision is made to avoid excessive pressure and if proper lubrication is maintained, a geared turbine should run a long time without overhauling. If from any cause wear of gearing or bearings is appreciable, the best remedy is replacement, which can best be done at a home port.

Operation and Maintenance

It has been frequently pointed out in this magazine that the steam turbine is the builders' job. It is delivered shut up in a box with instructions to maintain certain adjustments and to see that it is supplied with clean steam and oil. These instructions are simple, but to carry them out requires intelligence and vigilance on the part of the engineers. There is probably little that the engineer can do for the steam except to see that the boilers are run under regular normal conditions and to watch the feed water for contamination with oil and salt. Any salt in the feed water indicates trouble in the condenser, either from leaky or broken tubes. So long as direct acting steam pumps and other steam auxiliaries are used there is liability that oil will get into the condenser and boilers, even though the feed water is filtered. The engineer will find that the amount of oil may be kept down by keeping the auxiliaries in good condition and watching the younger engineers and oilers; the last is the most important.

The temperatures of the oil fed in and drawn out from

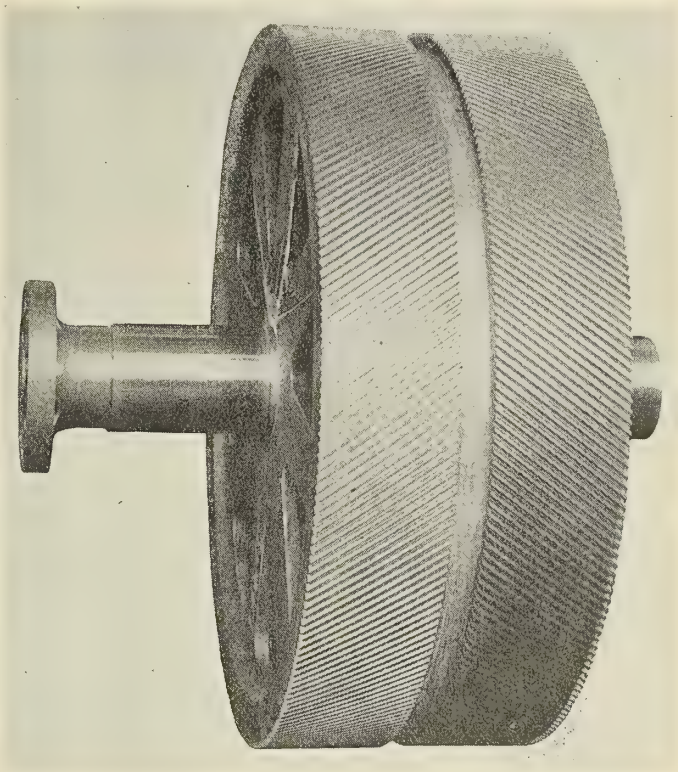


Fig. 12.—Low Speed Gear

the gearing and bearings should be watched with extreme solicitude; any sudden rise means that something is very wrong. Two things should be done at once: all the adjust-

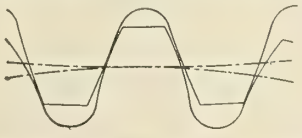


Fig. 13.—High Speed, 4-Pitch, 35-Degree Helical Angle Teeth

ments should be checked up and corrections made, if necessary, and the parts showing heating should be flooded with

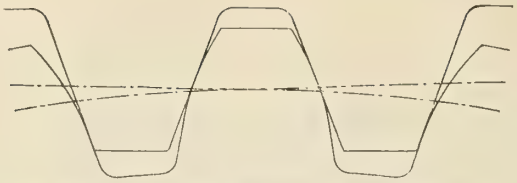


Fig. 14.—Low Speed, 2½-Pitch, 35-Degree Helical Angle Teeth

oil. The engineer should learn the simpler methods of testing oil and practice them as a regular routine, especially tests for presence of metal from the bearings. The engineer of a turbine steamer who knows his work and is on the alert should have a mind free from anxiety unless it may be for the fireroom.

Memorandum Governing Requirements for Fuel Oil Installation

Tanks

Tanks separate from hulls to be constructed of material not less than 5/16 inch in thickness.

Double riveted. Rivets spaced not more than four diameters from centerline to centerline.

Holes drilled and burrs removed after drilling.

Seams calked inside and out.

On wood vessels lead lining to be placed under tanks separate from hulls, lining to have a weight of not less than 8 pounds to the square foot.

Tanks to be properly braced and securely fastened to hull.

These tanks to be at least 18 inches from the boiler at all points, except back.

Valves to be placed on all tanks separate from hull at suction.

Tanks separate from hull to be tested to a hydrostatic pressure of 15 pounds.

Distance between tanks and back of boiler to be not less than 24 inches.

Double bottom tanks and other compartments to be tested as required by the American Bureau of Shipping.

Piping

Pipes and valves over 2 inches in diameter must be flanged to tanks.

Filling pipes must extend to bottom of tanks and must be fitted with U-bend extending upward at least 12 inches; or pipe brought to within one-half of its diameter of the bottom of tank.

Vent pipes must be the same area as filling pipes except a separate overflow is provided. If overflow is fitted with valves, check valve only allowed.

Vent pipes requiring bends must not use bends exceeding 45 degrees.

Upper ends of vent pipes to be carried above upper deck of superstructure, terminated in a U-bend properly covered with wire gauze.

Sounding pipes are not required by these rules, but if fitted must extend as close as practicable to bottom of tank.

Smothering pipes are not required, but if installed must be at least 1½ inches in diameter.

Pipes and connections between oil fuel feed pump and burners to be tested to 500 pounds on all high pressure systems.

Pipes between oil fuel feed pump and burners to be of extra heavy material.

Valves

Valves on all tanks to be accessible at all times or to have extension rods leading to deck.

Throttle valve of oil fuel feed pump to be provided with means of closing from a place outside the fireroom or pump room and not directly above the fireroom.

Valves over 2 inches in diameter to have bolted bonnets.

Tanks which are a source of supply to the pumps supplying the burners shall be fitted with an internal gate valve operated by an extension rod leading to an accessible point in an open space on deck outside the engine and fireroom casing.

Pumps

Transfer pump to be connected to oil fuel system only.

Openings

No holes to be cut in sides, bottoms or ends of tanks except for suction.

Heaters

Exhaust steam from coils used to heat fuel oil to be led to separate inspection tank, and in no case discharged into bilge.

Expansion Trunks

Expansion trunks extending above the deck must have all rivet holes drilled and be double riveted.

Fire Extinguishers, Etc.

On all vessels of over 500 tons there shall be in each fireroom a metal tank containing 50 gallons of sand and provided with scoop or shaker for fire purposes; also two approved fire extinguishers placed accessible to fireroom and ready for immediate use.

On vessels of 500 gross tons and under tank to contain 25 gallons of sand and one approved fire extinguisher.

Applications and Blue Prints

Application to be submitted to office of supervising inspector in triplicate.

Drawings or blue prints to be submitted to the office of the supervising inspector in triplicate, showing proposed installation.

Drawings or blue prints to show location, thickness and style of riveting of tanks.

In case of tanks separate from hull, fastening to hull should be shown.

Filling and vent pipes to be shown; also location of upper end of these pipes and connections at tanks.

Method of connecting all valves to tanks to be shown.

Oil fuel system proper to be shown. This includes pumps, heaters, valves and burners.

Extension rods from emergency shut-off for throttle of oil fuel feed pump and extension rods from oil suction valves to be shown.

Piping from oil fuel feed pump to burners to be shown extra heavy on all high pressure systems. (Any system using a pressure from a pump for atomizing is considered a high pressure system.)

Method of removing water from oil tanks and disposition of exhaust steam from heater coils.

Means of raising steam on boiler when it is cold, on vessels having one boiler.

Cost of Danish Shipping

According to the *Berlingske Tidende* of Copenhagen, the following table gives the cost of running a vessel of 2,400 tons deadweight at the present time and before the war.

	1914	1921
Daily expenses	$30	$139
Wages per month (not including war risk insurance on crew and officers' pensions 6 percent)	$263	$1,276
Food per man per day	15.6c	23c
Overtime on board	5c to 7c	31c to 38c
Price of coal in Great Britain per ton	$2.00 to $2.50	$12 to $14.00
Price of coal in Denmark per ton	$2.49 to $2.80	$18 to $26.50

Insurance rates have increased five to six times the amounts payable in 1914.

Diesel Engine Crankshafts

Investigation Made in Connection with Classification Rules of the American Bureau of Shipping

BY JOSEPH HECKING*

NO part of the Diesel engine is looked upon with as much suspicion as the crankshaft. The mechanism of the valves and the stresses in other parts due to heat and pressure are calculated to such a nicety that little serious trouble is experienced from this source, but crankshafts continue breaking apparently without cause. The reason for this condition is the fact that there are so many abnormal conditions and combinations of adverse circumstances in the life of a crankshaft that it is impossible to anticipate all such conditions in the calculations.

Law of Comparison

The writer recently asked a well-known engineering professor with regard to the proper method of calculating the crankshafts and received the startling answer: "The more you figure, the more you may be sure that you are wrong; the safest formula is this: $D^3/D_x^2 = d^3/d_x^3$, where D and D_x represent the diameters of the old and new cylinders respectively, and d and d_x the diameters of their crankshafts." In other words, if an engine works satisfactorily with a crankshaft of a certain size, a similar engine may have a shaft in the above proportions.

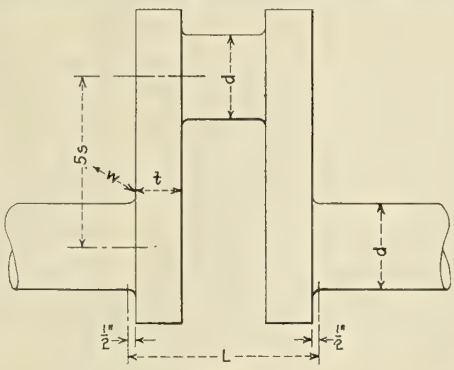


Fig. 1

Most crankshafts are designed in this manner, and even in the case of entirely new designs and where a thorough analysis has been made of all the loads and conditions involved, the engineer does not finally determine on the size of the shaft without consulting the plans of somewhat similar engines. This fact is not at all surprising, as experience only can verify our calculations and teach us the application of proper assumptions and constants. Considerable research work has been performed by engineers in the oil engine industry and many broken shafts have been replaced before we arrived at the safe sizes and safe materials for oil engine crankshafts.

* Engineer Surveyor, Scientific Department, American Bureau of Shipping, New York.

There are several fundamental requirements which apply to all shaft calculations alike, and these are: a rigid bedplate, solid foundations, sound material and good workmanship. Under these considerations the following analysis is offered to those who wish to acquire at least a general knowledge of the calculations involved and who desire a formula readily adjustable to suit varying conditions.

Terms Used

The following terms are being used in this analysis:

P = maximum initial pressure, pounds per square inch.
D = diameter of cylinder, in inches.
C = load in direction of connecting rod.
T = tangential force.
B = bending force.
M_t = twisting moment.
M_b = bending moment.
α = angle of crank and vertical centerline.
β = angle of connecting rod and vertical centerline.
δ = angle of connecting rod extension and tangential to crank circle.
EM_b = equivalent bending moment.
L = fore and aft length of crank over webs + 1 (inches).
f = allowable working stress per square inch.
a = crankshaft constants.
d = diameter of crankshaft.
t = thickness of crankweb.
w = width of crankweb.

Point of Maximum Strain

Taking at first a single cylinder engine under consideration it is essential to determine the point of maximum strain in the crankshaft. This point is given by various authorities as located between the crank angles of 25 and 35 degrees in the power stroke. A typical indicator card is shown in Fig. 2 (the pressure curve having been magnified in order to make clear the drop in pressures) and the positions of the piston and the crank for crank angles of 25, 30 and 35 degrees have been indicated to find the point of maximum strain.

In the top position the shaft is subject to bending only. The load on the piston equals $.7854D^2P$, the crankpin is assumed to be loaded in the center and the points of support one-half inch beyond the crankwebs (see Fig. 1). The bending moment is, therefore, $\frac{WL}{4} = .7854D^2P \times .25L = .196D^2PL$.

The process of the calculations to obtain the equivalent

TABLE I.

Crank = 1, stroke = 2, connecting rod = 4.5, length between bearings L = 2, S = L, bending moment = $M_b = \frac{WL}{4}$.

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Angle α	Piston Press.	Piston Load	Angle β	cos. β	$C = P/\cos.\beta$	Angle δ	$T = P \times \cos.\delta$	$B = P \times \sin.\delta$	$M_t = T \times .5S$	$M_b = B \times .25L$	tan. ϵ M_t/M_b	cos. ϵ	$EM_b = M_b/\cos.\epsilon$
Top	P	$.7854D^2P$	0	0	0	0	0	$.7854\ D^2P$	0	$.196\ D^2PL$	0	0	$.196\ D^2PL$
25°	$.947\ P$	$.744\ D^2P$	5° 23′	.996	$.746\ D^2P$	59° 37′	$.377\ D^2P$	$.643\ D^2P$	$.189\ D^2PS$	$.161\ D^2PL$	1.173	.649	$.248\ D^2PL$
30°	$.881P$	$.692\ D^2P$	6° 23′	.994	$.696\ D^2P$	53° 37′	$.413\ D^2P$	$.561\ D^2P$	$.207\ D^2PS$	$.140\ D^2PL$	1.48	.560	$.250\ D^2PL$
35°	$.753P$	$.600\ D^2P$	7° 20′	.992	$.605\ D^2P$	47° 40′	$.407\ D^2P$	$.447\ D^2P$	$.204\ D^2PS$	$.112\ D^2PL$	1.822	.481	$.233\ D^2PL$

TABLE II

Conn. Rod Cranks	Piston Load D^2P	Angle β	cos. β	$\frac{C}{D^2P}$	Angle δ	cos. δ	sin. δ	T in D^2P	B in D^2P	M_t in D^2PS	M_b in D^2PL	tan. ϵ M_t/M_b	cos. ϵ	$\frac{EM_b}{D^2PL}$
4	.692	7° 11′	.992	.698	52° 49′	.604	.797	.421	.556	.211	.139	1.518	.55	.253
4½	.692	6° 23′	.994	.696	53° 37′	.593	.805	.413	.56	.207	.140	1.479	.56	.250
5	.692	5° 44′	.995	.695	54° 16′	.584	.812	.406	.564	.203	.141	1.44	.57	.247

bending moments for the various crank positions is shown in Table I. Column 2 gives the piston pressure in relation to the maximum pressure; column 3, the corresponding load on the piston; column 4, the angle between connecting rod and vertical centerline of the engine, and column 5, the cosine of this angle; column 6, the load in the direction of the connecting rod (3 divided by 5); column 7 gives angle δ, dividing load C into T (column 8) and B (column 9) by multiplying C in column 6 by the cosine and the sine respectively of angle δ. Assuming now the crank length as unity $= 1$, the stroke equals 2, and for comparative purposes L may be taken as $= 2$. (The effect of the ratios of stroke to span between bearings will be investigated later.) The twisting moment in column 10 is therefore T in column 8 multiplied by the crank length or by $.5S$ and the bending moment in column 11 is B in column 9 multiplied by $L/4$ (see $\frac{WL}{4}$ above). Columns 12, 13 and 14 require explaining in detail.

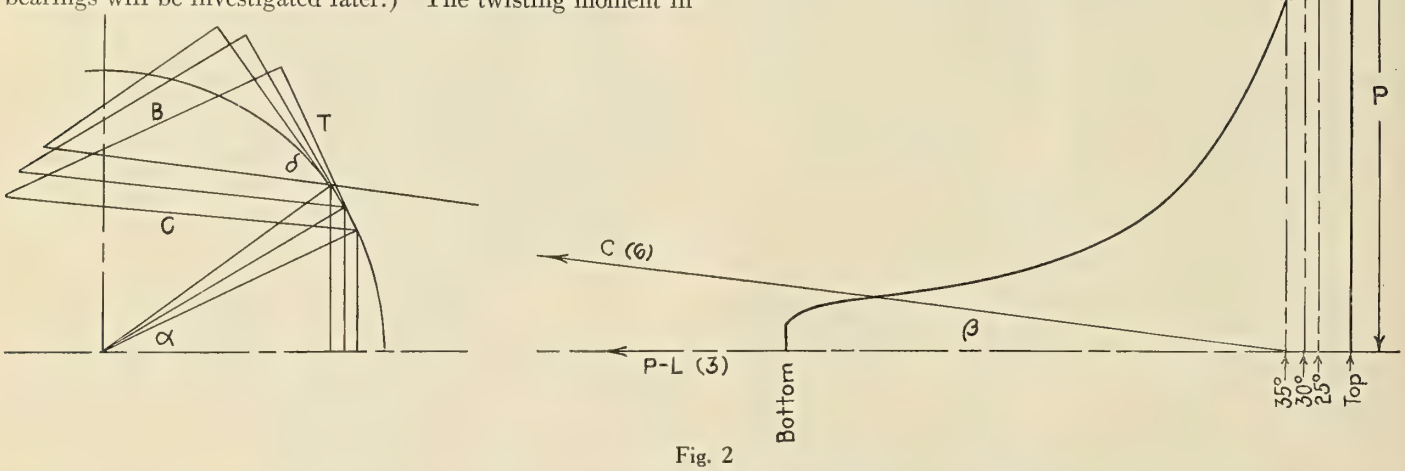


Fig. 2

Derivation of Equivalent Bending Moment

The generally accepted formula for finding the *equivalent* bending moment where the bending moment and twisting moment are known is $EM_b = \sqrt{M_b^2 + M_t^2}$. This value is easily recognized from the Pythagorean Theorem as the hypothenuse of a rectangular triangle, the two sides being M_b and M_t (see Fig. 3). Tan $\epsilon = \frac{M_t}{M_b}$; for the 25-degree position $\frac{.189D^2PS}{.161D^2PL} = 1.173 \frac{S}{L}$, and having in this case assumed $S = L$, tan $\epsilon = 1.173$. The corresponding cosine ϵ is .649 and the hypothenuse, or EM_b, equals the bending moment M_b divided by cosine $\epsilon = \frac{.161D^2PL}{.649} = .248D^2PL$.

Influence of Connecting Rod Length

The indicator card used in Fig. 2 is taken from a large six cylinder four cycle engine of modern design and shows a fairly even expansion curve, and inasmuch as no two indicator cards are alike, quite different values may be obtained by analyzing other cards, but the result as to the location of the point of maximum strain in the crankshaft varies very little. The assumption that this point is located at the 30-degree angle position of the crankweb in the power stroke is sufficiently correct for all practical purposes.

The above analysis is based on a connecting rod length of 4½ cranks, which is the average of present-day practice; rods of a length of 4 or 5 cranks will affect the proportions of M_t to M_b only to a minor degree, as shown in Table II.

Effect of Stroke to Length Ratio

In the foregoing analysis it has been assumed that the stroke S = distance between bearings L. A tabulation of a number of designs shows that the S/L ratio is subject to a variation from .75 to 1.35. It is evident therefore that any formula based on a fixed S/L ratio for all engines does not fairly cover the conditions, as the following indicates.

Referring to Table I, the ratio $S/L = 1$ for the 30-degree angle position gives the M_t/M_b ratio of 1.48. For $S/L = .7$, L is increased in the ratio of $1/.7$ or 1.43, and the M_t/M_b ratio for a constant M_t is $\frac{.207D^2PS}{.140D^2PL \times 1.43} = 1.035 =$ tan. ϵ. For $S/L = 1.4$, L is decreased in the ratio of $1/1.4$ or .715 and $\frac{.207D^2PS}{.140D^2PL \times .715} = 2.07 =$ tan. ϵ. The tangent for any S/L ratio may be more readily obtained by multiplying the tangent for $S/L = 1$ by the ratio in consideration, as $1.48 \times .7 = 1.035$.

These three conditions have been shown graphically in Fig. 4, indicating clearly that with a constant M_t and a variable M_b the effect of M_t on EM_b is greater with a decreasing

M_b and is smaller with an increasing M_b. The increase in EM_b from $S/L = 1$ to $S/L = .7$ equals 15.7 percent and the decrease from $S/L = 1$ to $S/L = 1.4$ equals 7.3 percent. The reduction of the stresses in the shaft induces the de-

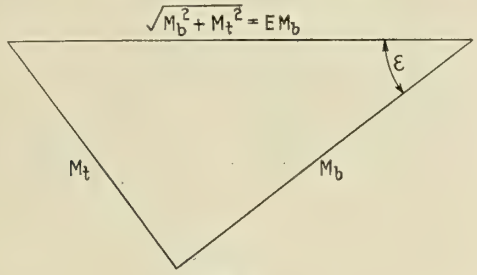


Fig. 3

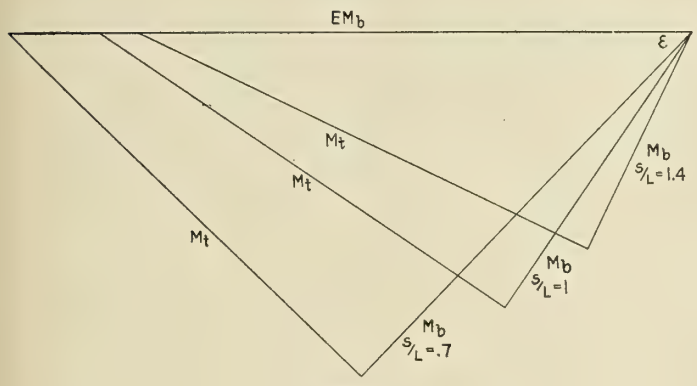


Fig. 4

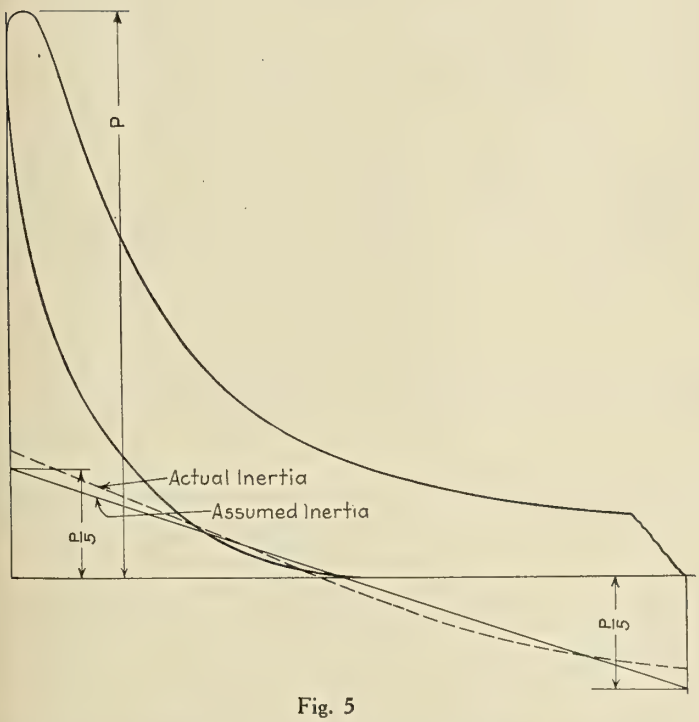
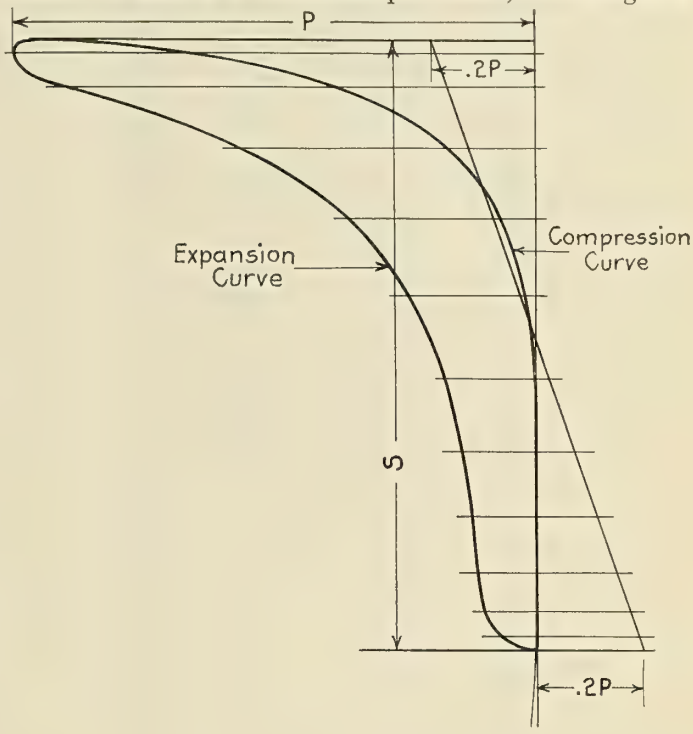


Fig. 5

lower dead center $p_a = \left(\frac{n}{30}\right)^2 \times wr\left(1 - \frac{1}{4.5}\right)$, where n = number of revolutions per minute, w = weight of



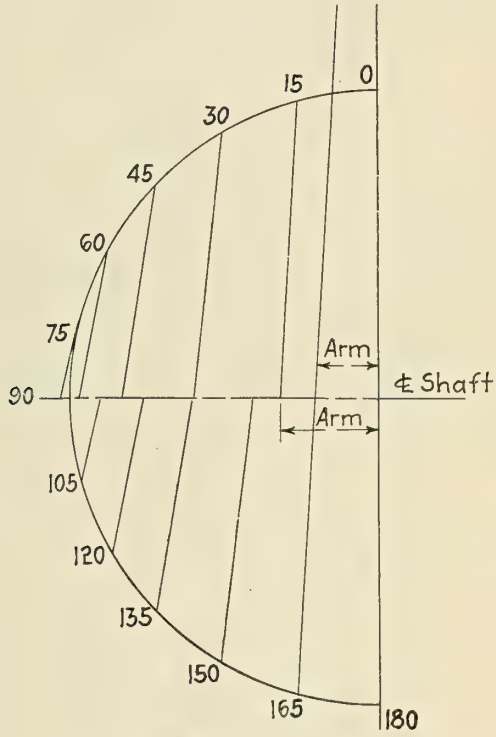


Fig. 6

signer to reduce the distance between bearings to a minimum.

The above investigation also emphasizes the necessity of taking the S/L ratios in consideration in formulating a rule for general application.

Inertia

A more serious problem for a general formula offers apparently the determination of average acceleration forces. The formula for the acceleration force at the upper dead center is $p_a = \left(\frac{n}{30}\right)^2 \times wr\left(1 + \frac{1}{4.5}\right)$, and for the

reciprocating parts per square inch of piston area, r = length of crank in feet, $\frac{1}{4.5}$ the crank to connecting rod ratio, and p_a pressure per square inch.

The characteristic curve of acceleration forces is indicated in Fig. 5 in dotted line. The principal determining features are the velocity and the weight of the reciprocating parts. The speed of an engine and also the weights depend to a large extent on its size. Only large oil engines are built of the crosshead type, and while the weight of the reciprocating

TABLE III.

Crank Angle	Piston Press % of P	Piston Load D^2P	Arm in % of S	Mt in D^2PS	
0	.78	.612	—	—	Power Stroke
15	.810	.636	.153	.097	
30	.733	.576	.294	.169	
45	.440	.346	.408	.141	
60	.290	.228	.481	.109	
75	.224	.176	.510	.090	
90	.2	.157	.500	.079	
105	.213	.167	.456	.076	
120	.24	.188	.387	.073	
135	.263	.207	.298	.062	
150	.267	.21	.200	.042	
165	.26	.204	.102	.021	
180	.2	.157	—	—	
195	—.193	—.152	.102	—.015	Exhaust Stroke
210	—.173	—.136	.200	—.027	
225	—.15	—.118	.298	—.035	
240	—.113	—.089	.387	—.034	
255	—.07	—.055	.456	—.025	
270	—.027	—.021	.500	—.011	
285	.03	.024	.510	.012	
300	.08	.063	.481	.030	
315	.127	.100	.408	.041	
330	.17	.134	.294	.039	
345	.193	.152	.153	.023	
0	—.2	—.157	—	—	Suction Stroke
15	—.193	—.152	.153	—.023	
30	—.17	—.134	.294	—.039	
45	—.127	—.100	.408	—.041	
60	—.08	—.063	.481	—.030	
75	—.03	—.024	.510	—.012	
90	.027	.021	.500	.011	
105	.07	.055	.456	.025	
120	.113	.089	.387	.034	
135	.15	.118	.298	.035	
150	.173	.136	.200	.027	
165	.193	.152	.102	.015	
180	.2	.157	—	—	Compression Stroke
195	—.193	—.152	.102	—.015	
210	—.173	—.136	.200	—.027	
225	—.15	—.118	.298	—.035	
240	—.113	—.089	.387	—.034	
255	—.07	—.055	.456	—.025	
270	—.03	—.024	.500	—.011	
285	+.03	+.024	.510	+.012	
300	+.013	+.010	.481	+.005	
315	—.04	—.031	.408	—.013	
330	—.227	—.179	.294	—.053	
345	—.50	—.393	.153	—.060	

parts is large, the speed is generally low; the designer takes care that the weights of fast-running, small trunk-type engines are kept down. From a comparison of a number of engines of various types it has been found that the average acceleration pressure is equal to 20 percent to 25 percent of the maximum piston pressure. A maximum acceleration force of 20 percent of the maximum piston pressure is probably an assumption on the safe side, bearing in mind that this is not a question of dissipation of power, but of relocation. The power absorbed in the first half of each stroke is returned during the second half, therefore not changing the total turning effort. The acceleration used in this analysis is shown in full in Fig. 5.

Turning Effort for Each 15 Degrees of Stroke

In Table III the turning efforts have been calculated for every 15 degrees of a complete cycle of a four cycle engine with due consideration of the inertia forces. It should be noted that the inertia is negative for the first half of *each* stroke and positive for the second half. For the exhaust and suction strokes inertia only need be considered; in the case of two cycle engines these two strokes are omitted.

Special attention is directed to the peculiar condition in the compression stroke (Fig. 6), where for the 285- and 300-degree positions the positive inertia pressure exceeds the negative compression pressure, resulting in a small positive turning effort.

While in Tables I and II the turning efforts have been determined by the triangle of forces as functions of angle δ, the graphical method has been used in Table III, where the M_t for any crank angle equals the load on the piston multiplied by the corresponding distance of the intersection of the connecting rod with the horizontal centerline of the shaft from the center of the shaft marked "arm" in Fig. 6.

Another modification is the omission of the resultant pressure due to angle β. Comparison of columns 3, 5 and 6 of Table I will show that the increase in pressure due to cosine β is rather trifling and may as a matter of convenience be omitted for a general analysis.

Table III forms the basis of calculating the size of the crankshaft for engines with any number of cylinders. Having found that the maximum stress for a single crank occurs at the 30-degree angle position, the stress in the shaft aft of the after crank of multi-cylinder engines is due to the bending and torque of the after cylinder plus the torque produced by the preceding cylinders. The piston load of one cylinder at the 30-degree position according to Table III is $.576D^2P$, of which the bending force M_b equals $\sin \delta = .805 \times .576D^2P = .464D^2P$ and the bending moment $.464D^2P \times .25L = .116D^2\,PL$; the torque has been determined graphically as $.169D^2PS$. The bending moment remains constant for any combination of cylinders.

The equivalent bending moment is derived by the method described in connection with Fig. 3 and the effect of the S/L ratio according to the explanation in connection with Fig. 4.

Total Twisting and Bending Moments of Various Engines

The sum of the twisting moments for the customary cylinder arrangements will equal crank angles, taken from Table III, are given in the first column of Table IV. In order

TABLE IV.—D^2PS

	Number of Cyl's	Cranks Apart	1	2	3	4	5	6	7	8 Average	9 Used
Four Cycle	1		.169	.152	.140	.137	.132	.156	.162	.150	.160
	2	360°	.130	.110	.113	.110	.105	.107	.119	.113	.160
	3	240°	.185	.171	.174	.172	.165	.187	.195	.178	.180
	4	180°	.076	.054	.041	.038	.037	.051	.064	.052	.160
	6	120°	.177	.172	.159	.162	.160	.178	.174	.169	.180
	8	90°	.218	.168	.167	.175	.174	.190	.197	.184	.190
	12	60°	.199	.197	.151	.169	.180	.189	.182	.183	.200
Two Cycle	1		.169	.152	.140	.137	.132	.156	.162	.150	.160
	2	180°	.142	.124	.111	.108	.105	.129	.135	.122	.160
	3	120°	.200	.195	.152	.154	.166	.170	.179	.174	.180
	4	90°	.220	.171	.168	.175	.176	.199	.200	.187	.190
	6	60°	.199	.198	.151	.169	.180	.189	.182	.181	.200
	8	45°	.246	.207	.179	.187	.192	.223	.212	.207	.225
	Mb	D^2PL	.116	.104	.096	.094	.090	.106	.111	.1025	.105

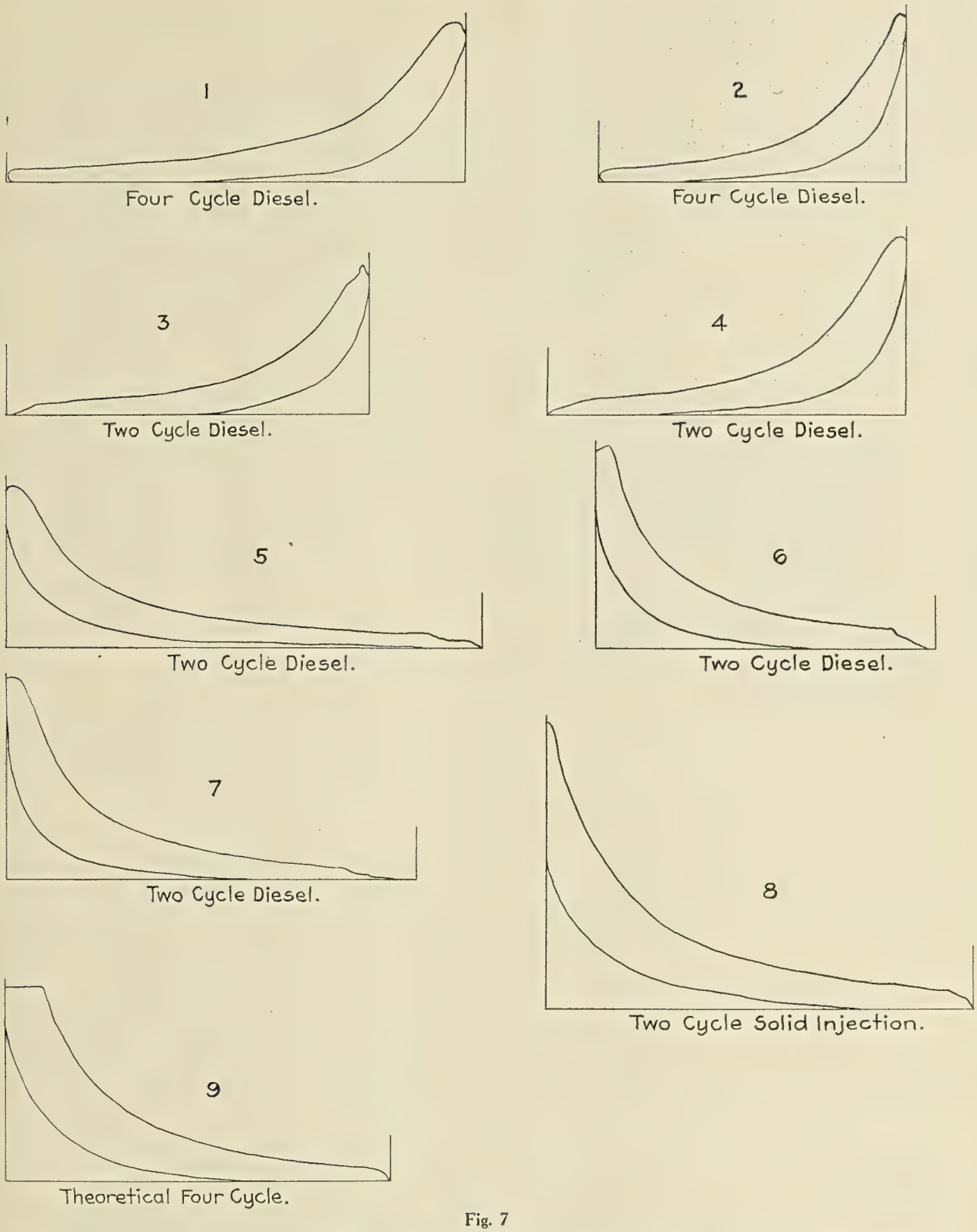


Fig. 7

to arrive at the turning and bending moments which may fairly and safely represent engines of various well-established designs (see Fig. 7), the indicator cards of six other engines have been analyzed in the same manner as the card shown in Fig. 6, and the turning and bending moments are also given in Table IV. The number at the head of each column corresponds with the number of the indicator card.

As a matter of general information and comparison, the theoretical indicator card No. 9 and a card of a solid injection engine No. 8 have been shown. Owing to the possibility of extending the time of the fuel admission in solid injection engines so that their cards appear more like the straight Diesel card (Vickers engine), the formula for Diesel engine crankshafts should also cover solid injection engines. While all cards represent normal working condition, it is possible that some are slightly overloaded and some under loaded.

No conclusions should be drawn from the cards as to the relative efficiency of the engines, as any engine may be made to produce a fuller card by increasing the fuel supply. All cards have been analyzed for 4- and 2-cycle. The average turning moments and bending moments are given in column 8.

The turning moments for single and multi-cylinder en-

gines, column 9, and the bending moment applying to all engines in the last line of column 9, which have been decided upon as representing the maximum load acting on the crankshaft, require some explanation. A two-cylinder engine (four- or two-cycle) running with one cylinder damaged and cut out would in effect be a single-cylinder engine and require a shaft equal to this condition. The turning efforts of a four-cylinder four-cycle engine are affected to a minor degree by the elimination of one cylinder; while the probability of running a four-cylinder engine on one cylinder is rather remote, prudence would advise to take care of such a condition by making the shaft equal to this condition. For the same reason the shaft of a six-cylinder four-cycle engine should not be smaller in diameter than the shaft for a three-cylinder four-cycle engine, although the normal turning efforts would permit it.

A closer examination of the turning efforts of 8- and 12-cylinder four-cycle engines reveals the fact that the peak of the turning effort curve lies forward of the 30-degree crank position (see also "The Diesel Engine," by Herbert Haas). The previous assumption that the point of maximum strain in the crankshaft is at the 30-degree crank position, requires therefore a modification. The bending moment increases from the 30 degree to the top dead center position (see Table 1). In order to maintain a constant bending moment M_b a corresponding increase has been made in the variable turning moment M_t, producing the same result as an increased M_b.

The above explanations apply also to two-cycle engines, where the turning efforts in column 9 of Table IV, have been perceptibly increased over the average values in column 8.

Working Formula

The section modulus of a circular shaft is $.098d^3$ *or* $\frac{d^3}{10.2}$.

If "f" represents the allowable fibre stress,

$$\frac{d^3 f}{10.2} = EM_b \text{ or } d = \sqrt[3]{\frac{10.2 \times EM_b.}{f}}$$

EM_b consists of the numerical value "v" (see Table I), and the constant D^2PL; the derivation of the value "v" is shown in Table V. By extracting the cube root of the product $10.2v$, this value may be placed in front of the root sign as a constant "a," so that the formula takes the form of

$$d = a\sqrt[3]{\frac{D^2PL}{f}}$$

The value of "a" for the various turning moments and the constant bending moment of Table IV are determined as shown in Table V.

Example

As an illustration of the operation of the above formula, the curves for single and multi-cylinder engines with cylinders 20 inches diameter, 30 inches stroke, and a maximum working pressure of 500 pounds per square inch, are shown in Fig. 8. There are two curves, one for $S/L = .7$ and one for $S/L = 1.3$. The allowable working stress of the material has been taken as 7,500 pounds, representing material of an ultimate tensile strength of 60,000 pounds and a factor of safety 8. The constant for any number of cylinders is

$\sqrt[3]{\frac{D^2PL}{f}}$, which for the above cylinders and for $S/L = .7$ equals 10.47, and for $S/L = 1.3$ equals 8.49. These values multiplied by the value of "a" (Table V) corresponding to the number of cylinders under consideration give the diameter of the shaft.

TABLE V.

Number of cylinders	S/L	tan. ϵ	cos. ϵ	$M_b/\cos\epsilon = vD^2PL$	$\sqrt[3]{10.2v} = a$
1-2-4 cylinders, 4 cycle 1-2 cylinders, 2 cycle $M_t = .160\ D^2PS$. For $S/L = 1$ $\tan.\epsilon = \frac{.160\ D^2PS}{.105\ D^2PL} = 1.523$	.7	1.065	.685	$.153\ D^2PL$	1.16
	1.0	1.523	.549	$.191\ D^2PL$	1.25
	1.3	1.980	.451	$.233\ D^2PL$	1.34
3-6 cylinders, 4 cycle 3 cylinders, 2 cycle $M_t = .180\ D^2PS$. For $S/L = 1$ $\tan.\epsilon = \frac{.180\ D^2PS}{.105\ D^2PL} = 1.715$	.7	1.20	.640	$.164\ D^2PL$	1.19
	1.0	1.715	.504	$.208\ D^2PL$	1.28
	1.3	2.28	.409	$.257\ D^2PL$	1.38
8 cylinders, 4 cycle 4 cylinders, 2 cycle $M_t = .190\ D^2PS$. For $S/L = 1$ $\tan.\epsilon = \frac{.190\ D^2PS}{.105\ D^2PL} = 1.81$	.7	1.267	.619	$.170\ D^2PL$	1.20
	1.0	1.81	.484	$.217\ D^2PL$	1.30
	1.3	2.355	.391	$.269\ D^2PL$	1.40
12 cylinders, 4 cycle 6 cylinders, 2 cycle $M_t = .200\ D^2PS$. For $S/L = 1$ $\tan.\epsilon = \frac{.200\ D^2PS}{.105\ D^2PL} = 1.905$	.7	1.335	.599	$.176\ D^2PL$	1.22
	1.0	1.905	.465	$.226\ D^2PL$	1.32
	1.3	2.475	.375	$.280\ D^2PL$	1.42
8 cylinders, 2 cycle $M_t = .225\ D^2PS$. For $S/L = 1$ $\tan.\epsilon = \frac{.225\ D^2PS}{.105\ D^2PL} = 2.142$	.7	1.498	.553	$.190\ D^2PL$	1.25
	1.0	2.142	.423	$.248\ D^2PL$	1.36
	1.3	2.783	.338	$.311\ D^2PL$	1.47

Dimensions of Crankwebs

The determination of the dimensions of the crankwebs should be carefully considered in the design of each engine. The temptation to reduce their thickness in order to shorten the length of the engine is rather alluring but may lead to disaster. Experience has shown that by far the greater number of crankshafts break through the web on the line m-n, indicated in Fig. 9. Especially in the top dead center position, the loads and stresses are somewhat indeterminable, considering the possibility of uneven bearing levels, deflections due to the loads on the adjoining cranks and temporary excessive pressures, or a combination of the above. The tendency of design should therefore be in the direction of "safety first."

A satisfactory approximation may be obtained by the following method, basing the strength of the web on the strength of the crankpin. The shaft is considered supported at the center of each bearing (Fig. 9). Allowing again a 20 percent reduction in the maximum pressure for inertia, the load in the top dead center position is $.8 \times .7854D^2P = .628D^2P$. The maximum bending moment for the crankpin is therefore $.628D^2P \times L/4 = .157D^2PL$. The section modulus of the shaft is $.098d^3$, and $.157D^2PL = .098d^3f$, or $1.6D^2PL = d^3f$. The reaction at each bearing is $.314\ D^2P$, the moment from the centerline of the bearing to the center of the web is about $.25L$ and the bending moment $.314D^2P \times .25L = .08D^2PL$. The section modulus of the web is $\frac{t^2w}{6}$ and $.08D^2PL = \frac{t^2w}{6}f$, or $.48D^2PL = t^2wf$. The relative dimensions of crankpin and

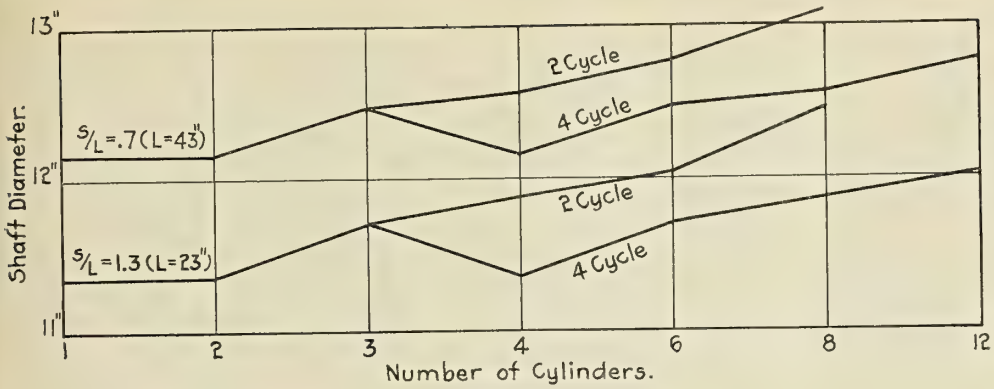


Fig. 8

web are therefore $\frac{1.6D^2PL}{d^3f} = \frac{.48D^2PL}{t^2wf}$ or $.3d^3 = t^2w$.

This proportion is based on bending forces only. The magnitude of the turning forces depends on the number of the cylinders. It would lead too far to recite here the assumptions of how this turning effort may be transmitted from the forward to the after web. It is evident that the web, having the greater moment, is subject to a more severe strain than the crankpin, which is partly protected from deflection by the surrounding connecting rod box. The above ratio of crankpin to crankweb is therefore increased to $.4d^3 = t^2w$, in accordance with good practice.

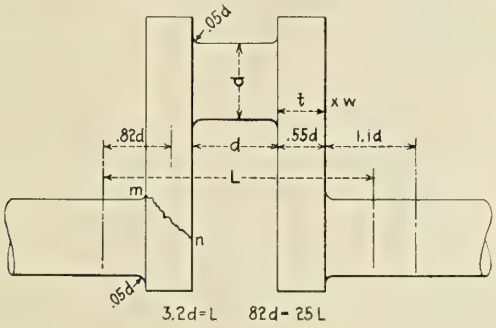


Fig. 9

For the point of maximum torque the section modulus of the shaft $= .196d^3$ should equal the section modulus of the web $= \frac{w^2t}{6}$ or $1.18d^3 = w^2t$. The ratio $d^3 = w^2t$ has been found adequate.

The crank webs of built-up crankshafts are made to the proportions inherited from the reciprocating engines, that is, the thickness of the webs $= .66d$ and the width from 1.9 to 2 times the diameter of the hole in the webs.

Shaft Material

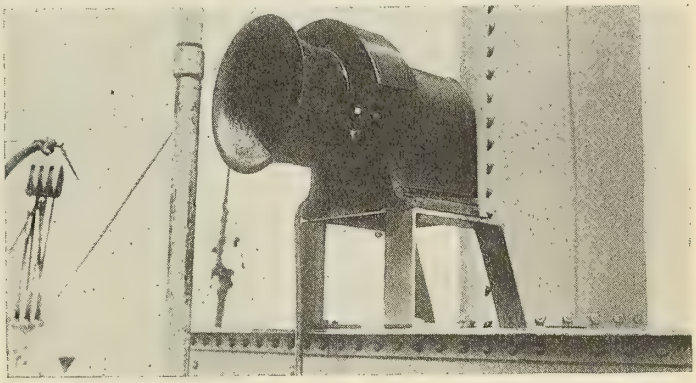
Two grades of steel are used for marine engine crankshafts, the ordinary marine steel of 60,000 pounds ultimate tensile strength, 50 percent yield point and 26 percent elongation and steel of 70,000 pounds ultimate tensile strength, 50 percent yield point and 22 percent elongation. The latter material is the more widely used. The working stress for the first is 7,500 pounds and the latter 8,000.

Electric Siren for Motorships

THE problem of providing motor driven vessels with economical and practical sound signalling devices was solved by a Seattle shipbuilding concern when it equipped the motorship *Benowa* with an electric siren. The first installation was made several months ago, and it has been so successful that since then many other motorships have likewise been equipped with them.

The siren used on the *Benowa* is a single head size siren known as type "B," manufactured by the Federal Electric Company, Chicago. It is claimed that it can be heard for more than a mile and a half and that the double head size sirens manufactured by the same concern can be heard for more than three miles.

The advantages of the electric siren over an air compressor is that the siren may be installed at one-fifth the cost of an air-sounding device and that its maintenance cost is at least one-tenth. When an air compressor device is used it is necessary to keep the motor running almost constantly to maintain sufficient air pressure, whereas in the case of a siren the motor is used only when the siren is used.



Federal Electric Single Head Siren Mounted on Motorship *Benowa*

The siren can be set in motion from various parts of the ship by merely pressing a button, when it gives a peculiar, penetrating sound, universally known to seamen as a warning signal. Hundreds of electric sirens are used by the United States Government on submarines and the like.

It is necessary to oil the siren only two or three times a year. The cost of operation for actual current consumed is only about two or three dollars a year. Every part of the siren is enclosed. The rotors are made of aluminum and cast in one piece. The horn is of cast iron. The motor drives the rotor and its revolution at a high rate of speed draws air into the large bell-shaped openings or horns at either end of the siren and forces it out through ports in the stationary housing. The alternate opening and closing of these ports by the turning of the rotor produces the characteristic sound of the siren, and the rising and falling sound, which makes it so distinctive and effective, is the result of change of speed of the motor.

Prosperity of Italian Shipyards.—Italian shipyards, it is stated, are enjoying quite a run of prosperity. There is actually a larger tonnage under way in these yards than in any other European country except England. Italian shipyards have at present 57 steel steamers of 413,727 tons deadweight in construction of which 24 are being completed afloat, and 33 are still on the way. It is also stated that orders have been booked for an additional 39 steamers of 316,310 tons deadweight. Four wooden steamers of 5,075 tons deadweight are also building.

New Shipyards for the Argentine.—An Argentine company is being formed at Buenos Ayres, with a capital of 50,000,000 pesos, with the object of establishing shipbuilding yards at the port of Carmen de Patagonia, and constructing vessels for trading with Europe.

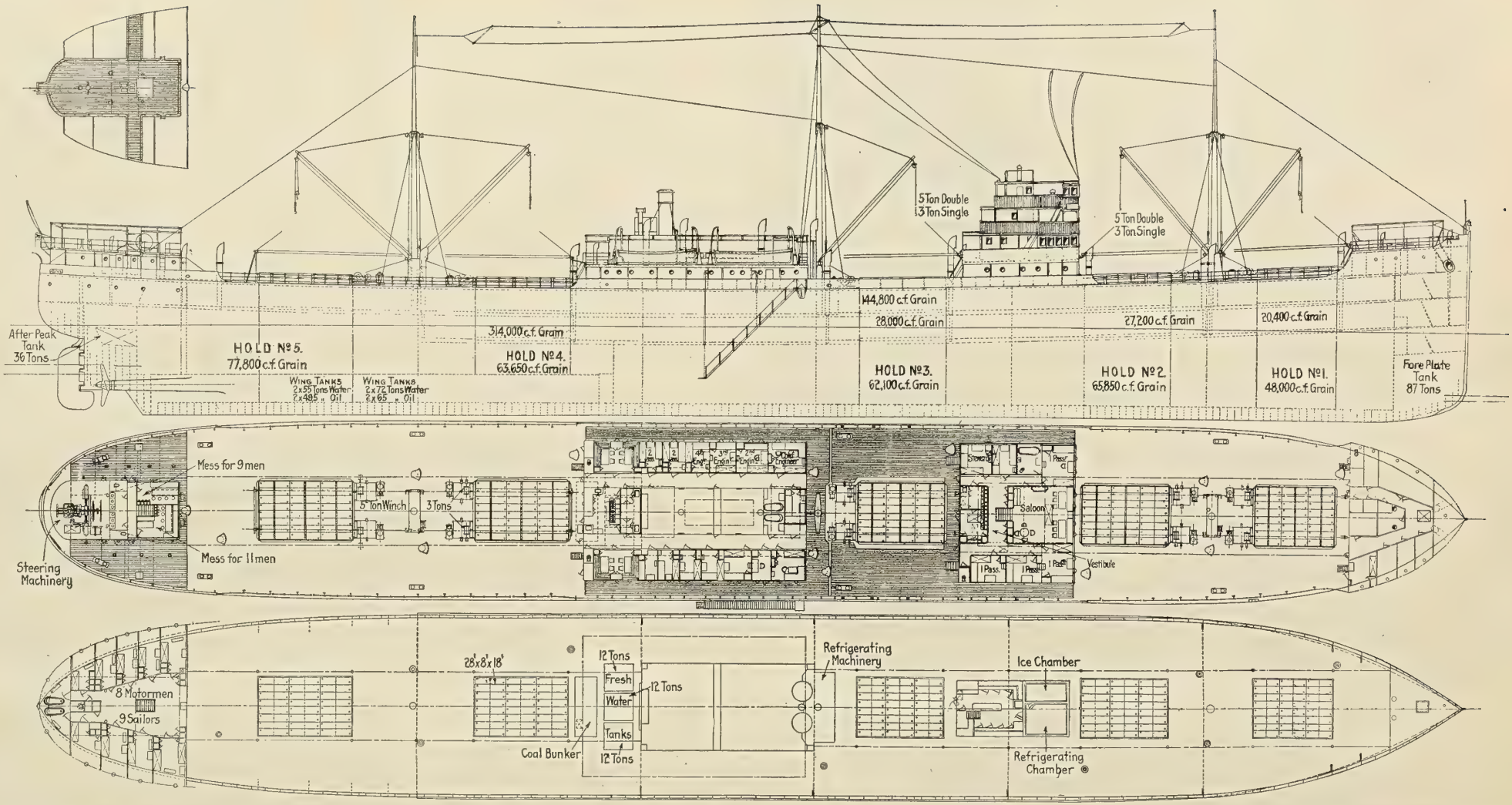


Fig. 1.—General Arrangement Plans of Motorship for the Swedish East Asiatic Company: Length Between Perpendiculars, 425 Feet; Beam, 56 Feet; Depth, 38 Feet; Draft, 27 Feet 6 Inches; Deadweight Tonnage, 10,400; Indicated Horsepower, 4,000

Fig. 2.—The New 12½-Knot, 14,000-Ton Motorship *Glenapp,* Built by Harland & Wolff

Motorship Building in Europe

BY OUR SPECIAL LONDON CORRESPONDENT

The vitality of the motorship building industry in Europe and the interest which it is arousing among engineers and shipbuilders is well indicated by the large number of technical papers which are now being read before many of the leading British engineering and shipbuilding societies. Still more important perhaps is the energetic discussion which these papers invariably arouse, and the attendance of some of the best known experts on internal combustion engines at the meetings shows clearly the enthusiasm which centers round this, the latest development in shipbuilding.

ONE of the most valuable lectures that has been delivered is that of Professor (late Commander R. N.) Hawkes before the North East Coast Institution of Engineers and Shipbuilders on Fuel Injection in Diesel Engines. Professor Hawkes was during the war in charge of the Admiralty experimental stations where very careful investigations were made into the problem of adopting oil engines for war vessels, including submarines and larger ships. In his paper a full account is given of the results achieved. He dealt more particularly with fuel injection and provided a large amount of important data on the vexed question of the relative advantages of solid and air injection.

There is no problem which in Great Britain is attracting more attention than this, as there are two schools of thought. On the one side it is held that air injection must ultimately be replaced by the employment of mechanical pumps for injecting the fuel into the cylinders; on the other hand, many engineers still believe that air injection will remain the most popular system on account of the fact that air compressors have now reached a remarkable degree of reliability and also because solid injection does not allow of the employment of the lower grades of fuel which are now becoming common.

There is no question whatever of the success of solid injection, which, as is well known, is now adopted by Vickers in all their mercantile engines and by Doxfords in their remarkable new opposed piston type. However, proofs are not yet available that this success will be maintained when such poor fuel as Mexican oil is used, and those who adhere to air injection claim that within the next few years all motorships will have to burn the crudest oil, as there will be a shortage of the lighter qualities. This is the crux of the question, and although Doxfords claim that in their new engine they are able to utilize Mexican fuel oil such as is now burned under boilers, it will be impossible to attach much importance to this claim until the first ships equipped with their engines have been in service for a considerable time. Obviously if the air compressor can be eliminated and no corresponding disadvantages accrue, solid injection must gain universal adoption.

The Success of Solid Injection

In the meantime, remarkable success has been attained with the first Vickers engined motorship built since the war (the *Narragansett*) in which this system is utilized. It is not often that owners go out of their way to state this fact, but when the second similar ship was launched for the Anglo American Petroleum Company a short time ago, Mr. F. E. Powell, chairman of this firm, stated that the motorship was successful in every way and was only burning about one-third of the amount of fuel used in a corresponding vessel fitted with oil-fired boilers.

The new ship just launched is the *Seminole,* and she is exactly similar in every respect to the first vessel, the *Narragansett,* carrying 10,500 tons of oil fuel at a speed of 11 knots and being fitted with two 1,250 brake horsepower Vickers Diesel engines of the four cycle solid injection type. A curi-

ous point in the design of these motors is that instead of adopting the system now commonly employed, of fitting one fuel pump for each cylinder, there are four plunger pumps for each engine, delivering into a common rail from which the individual fuel valves receive their supply. This arrangement has lately come in for some criticism, but Vickers defends it as having proved entirely satisfactory on submarine engines. It may be noted also that Doxfords are more radical in their design, since they employ only one fuel pump of relatively large size, discharging the oil at 7,000 pounds per square inch through a distribution box whence pipes are taken to the separate fuel valves.

Harland and Wolff's Big Programme

To those who are not aware of the recent development in motorship building in Great Britain the programme of Harland and Wolff, the well-known Glasgow and Belfast shipbuilders, for 1921 will come somewhat as a surprise. During the course of the year it is hoped to complete four 14,000-ton ships for the Glen Line, five 10,000-ton vessels for the same owners, three 12,000-ton and one 10,000-ton craft for the Pacific Steam Navigation Company, one 12,000-ton ship for the Bibby Line, and one 10,000-ton vessel for Lamport and Holt, making a total of fifteen ships in all with a deadweight tonnage of 174,000 tons equipped with machinery of 68,800 indicated horsepower. It is to carry out this policy that the two enormous engine building works have been equipped on the Clyde, probably capable of an output of at least three times as many oil engines as is possible in any other existing works.

The second of the 14,000-tonners, the *Glenapp,* was completed in December and followed her sister ship, the *Glenogle,* on the Eastern run. No trouble whatever has been experienced with the 3,200 indicated horsepower engines installed in the first vessel, and it is anticipated that larger sets, probably of about 4,000 indicated horsepower, will be built, increasing the cylinder diameter to a considerable extent and using only six cylinders instead of eight. Thus the four cycle motor is approaching the two cycle set in cylinder output, and the struggle for supremacy between the two types will seemingly be very acute.

The Swedish East Asiatic Company, one of Mr. Dan Brostrom's concerns, has just placed an order for a large motor vessel of a well-known Scandinavian type, carrying 10,400 tons of cargo and fitted with two 2,000 indicated horsepower, six cylinder engines. This is practically similar to the three vessels now operated by the Transatlantic Company and which are stated to have proved the most successful vessels ever built for this firm, maintaining a regular sea speed of 12 knots on a fuel consumption of not more than 12 to 13 tons per day. The dimensions of these vessels are:

Length between perpendiculars	425 feet
Beam	56 feet
Depth	38 feet
Draft	27 feet 6 inches

Their general design can be noted from the plans (Fig. 1).

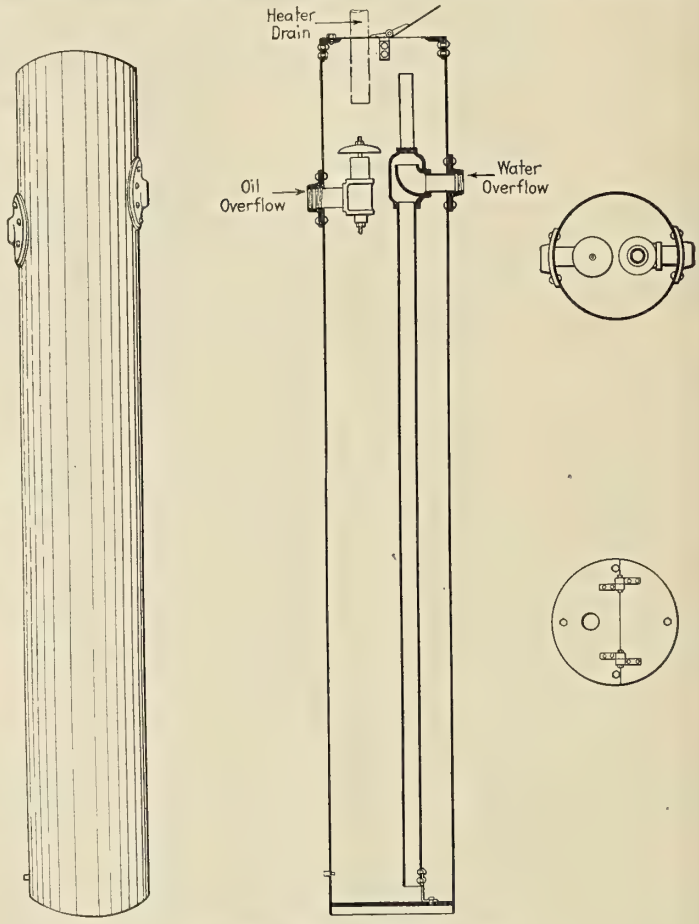
The Supply of Oil Fuel

Needless to say, Lord Pirrie's remarks on his return from America on the subject of the supply of oil fuel, which have been published broadcast, have excited widespread attention, since Lord Pirrie is, at the same time, the largest builder of motorships and controls more craft of this class than any other British shipowner. He states quite frankly that to use oil under boilers is wrong in principle and should be avoided except on express passenger liners, but he advises shipowners to be careful about adopting motor vessels unless they are assured of their oil supplies. These are reasonable statements, but the oil companies have not been long in pointing out that there should be no difficulty in providing all the oil required for motor vessels, no matter how rapidly the number may grow. The chairman of the Anglo American Oil Company and Sir Chas. Greenway, the head of the Anglo-Persian Oil Company, are both equally emphatic upon this point and, moreover, both agree with Lord Pirrie that oil should be used in motor vessels and not in oil fired boilers on steamships. Sir Chas. Greenway stated that, whereas now there were probably not more than 10,000,000 tons of oil available outside the countries in which it was produced, in two or three years time this amount would have increased to 50,000,000 tons, which is equivalent in power production, if used in Diesel engines, to 175,000,000 tons of coal.

On all sides, therefore, it would appear that there is an optimistic spirit in regard to the future supplies of liquid fuel for motorships, while the view is widely expressed that as soon as the tanker shortage is remedied, which will probably be the case within the course of the next twelve months, not only will there be an enormously increased supply of oil fuel available, but that its price will be considerably diminished. This is not merely the opinion of the buyer whose wish might be father to the thought, but the view has been publicly expressed by those in control of some of the leading oil concerns.

New Babcock and Wilcox Oil Separator

A DEVICE which not only detects oil leakage and separates oil from water, but also discharges the oil and water separately, is being brought out by the Babcock & Wilcox Company, 85 Liberty street, New York. The combination detector and separator was designed by Mr. John Coleman, their chief operating engineer.



Details of New Oil Separator

In operation, the simplicity of the separator and its automatic operation are regarded as its crowning features. Heretofore on oil burning ships oil leakage was returned from the heaters to an observation tank, where, if the engineer discovered it soon enough, he could avoid its getting into the boil-

ers, begin a search for the leak and repair it before material damage was done. On the other hand, if not noticed promptly, the oil leakage was returned with the feed water into the boilers, where it had extensive capacity for damage.

The Babcock & Wilcox separator consists of a 1-foot 4-inch by 9-foot 3-inch tank (approximate standard size) with two outlets, one for water overflow and one for oil overflow. It will be noted that the oil overflow is 1 inch higher than the water overflow. Oil returning with the drains from the fuel oil heaters will be deposited on the surface of the water within the separator, where it will be accumulated until the difference in the weight of the oil and the weight of the water will bring about a height difference of 1 inch, and should more oil enter the separator it will overflow through the oil outlet. Water returning through the separator will overflow at the lower level after passing up the pipe leading to the water overflow, this operation being continuous from this point on.

It will be further noted that as the operation of the separator is automatic it will not require any attention on the part of the engineers in order to eliminate oil getting ino the boilers, as at present is said to be the case with other devices now in use.

A receptacle under the oil overflow piped to the suction of the oil pump makes reclamation of oil possible. The separator has been given exhaustive tests and proved satisfactory. Patents have been applied for.

Marine Steam Practice*

BY ESKIL BERG†

At the present time in this country 200 pounds steam pressure seems to be the limit of pressure considered. The reason, no doubt, is that this pressure seems to be the limit at which the old reliable Scotch boiler can be used. In new passenger vessels now being considered, 275 pounds pressure at the boilers is going to be used, but, of course, watertube boilers have to be employed.

Superheat

Superheat has been used for many years by European shipowners—in fact, where economy is desired, superheat must be used. While superheat can be, and is now being, used by thousands of reciprocating ships, giving from 10 to 15 percent saving in fuel, the engine must be of special design to operate satisfactorily. All the auxiliary engines must also be of special design to give reliable operation, or else they must be operated by dry steam led to them by special piping, the steam being taken from the boiler before it reaches the superheater coils.

This, of course, is a make-shift and, besides, when we consider that from 25 to 35 percent of all the steam from the boilers is used to drive the auxiliaries, it is a terrible waste of fuel.

Steam turbines are particularly well adapted for superheat. The friction loss inside the turbine is reduced to a minimum by the introduction of superheat. This means long life, smooth running and economy.

In the Curtis type of turbine there is a gain of practically 1 percent for every 12 degrees of superheat. In other words, the steam consumption is reduced 16.7 percent with 200 degrees of superheat, as will be explained later. This in practice means practically the same amount in fuel consumption.

In connection with engines using superheat it must be remembered that every steam locomotive, operating on the main railroad line, is using very highly superheated steam (temperature of steam, 650 to 700 degrees). The economy by the use of superheat on locomotives has proven itself so great that it is to-day considered absolutely necessary. How much longer can the steamship owner overlook this great saving in fuel?

Auxiliaries

The auxiliaries of the type now used on board ships consume from 25 to 40 percent of the total steam generated by the boilers. This is a terrible waste of steam, which means fuel.

This exhaust steam is from three to four times more than that required to heat feed water and the surplus is allowed to exhaust into the condenser.

The energy of this steam is thus thrown away and, in some cases that have lately come to my notice, amounts to as much as 500 or 600 horsepower.

This auxiliary steam overloads the condenser 50 to 75 percent, and thus there is bound to be inferior vacuum, also increased power required to drive the circulating pump, condensate pump and air pump.

No power house on shore can afford to use such inefficient auxiliaries.

The simplest solution is, of course, to drive as many of the auxiliaries as possible by electricity, with power supplied from an efficient type of turbine that is designed to handle highly superheated steam. In older ships now operating the surplus exhaust steam should be admitted to a lower stage in the turbine, thus producing additional power which means lowering the temperature of the steam before it reaches the condenser, thus reducing the load on the condensing equipment.

High Steam Pressure

The effect of high steam pressure was also discussed and showed how enormous saving could be obtained by its introduction. In fact it was shown how, by the use of steam at 800 to 900 pounds pressure, and 150 degrees superheat, results could be accomplished that would compare favorably with Diesel engines.

High Vacuum

Mr. Berg explained in detail the importance of maintaining a high vacuum when steam turbines were used as prime movers.

The energy in one pound of steam between 28 inches and 29 inches of vacuum is as much as between 200 pounds steam pressure and 125 pounds. In other words, it is just as wrong to operate the turbine with 28 inches of vacuum when 29 inches can be obtained, as it would be to operate the boilers at 125 pounds steam pressure when the boilers were supposed to carry 200 pounds.

* Abstract of lecture delivered at recent meeting of the Ocean Engineers Beneficial Association No. 80, New York.

† Turbine Engineering Department, General Electric Company, Schenectady, N. Y.

Lloyd's Shipbuilding Returns

According to the returns compiled by Lloyd's Register, which only take into account vessels of 100 tons gross and upwards, there were 921 merchant vessels of 3,708,916 gross tons under construction in the United Kingdom at the close of the three months ended December 31, 1920. In September, 1920, the corresponding figures were 961 vessels of 3,731,098 gross tons. The tonnage now under construction in the United Kingdom is about 22,000 tons less than that which was in hand at the end of the last quarter.

In shipyards abroad, 1,509 vessels of 3,470,826 gross tons are under construction, making the grand totals for the whole world 1,980 vessels of about 7,176,778 gross tons, or about 385,000 tons less than the September total.

The present figures for the United Kingdom include 64 steamers and motor vessels of 422,553 gross tons, which are intended to carry oil in bulk. Of the total number of vessels under construction, 4 steamships are between 10,000 and 12,000 tons, 28 steamships are between 12,000 and 15,000 tons, 25 steamships are between 15,000 and 20,000 tons and 7 steamships are between 20,000 and 25,000 tons.

Merchant Marine Association Holds Convention

Prominent Men Discuss Policies and Legislation Necessary to Aid the Development of the American Merchant Marine

THE annual convention of the National Merchant Marine Association was held at the Hotel Washington, Washington, D. C., January 20-21. Senator Joseph E. Ransdell, president of the association, presided and delivered the opening address. Members of the Mississippi Valley Association and the South Atlantic States Association attended the convention and contributed several valuable papers relating to the shipping situation.

Senator J. E. Ransdell

Senator Ransdell in his opening address urged the repeal of the Panama Canal tolls on American vessels, support for the Shipping Board, a fair trial for the Merchant Marine Act of 1920, and some form of aid to American shipping to offset the lower operating costs of foreign competitors.

The senator stated that our coastwise commerce is purely a domestic matter and whether or not such commerce paid tolls for passage through the Panama Canal should be of no concern to foreign lands. Referring to the Merchant Marine Act, the senator stated that he was sure the vast majority of the people are disposed to give it a fair trial. He thought that it was the duty of Congress to develop advantages that would offset the burdensome obligations that ship operators have to assume in competing with the merchant fleets of other nations.

Senator Wesley L. Jones

Senator Jones, chairman of the Senate Committee on Commerce and author of the Merchant Marine Act of 1920, made the charge that British interests have been carrying on a campaign for years to destroy our merchant marine. In support of these charges the senator submitted copies of a twenty-year written agreement between the British Government, the International Mercantile Marine Company and British shipping companies in which the International Mercantile Marine Company contracts to pursue "no policy injurious to the British mercantile marine or the British trade." According to this agreement, the Lord High Chancellor of Great Britain shall be the sole judge of whether the policies of the International Mercantile Marine Company are favorable to British shipping or not.

Copy of Agreement

Copy of agreement (dated August 1, 1903) between the Admiralty and the Board of Trade, the International Mercantile Marine Company and the Oceanic Steam Navigation Company Limited, Frederick Leyland & Company (1900), Limited; the British and North Atlantic Steam Navigation Company Limited; the Mississippi and Dominion Steamship Company, Limited; the Atlantic Transport Company Limited, and the International Navigation Company Limited.

An agreement made the first day of August, 1903, between the commissioners for executing the office of lord high admiral of the United Kingdom of Great Britain and Ireland and the Board of Trade (for and on behalf of his Majesty's Government); of the first part; the International Mercantile Marine Company (formerly known as the International Navigation Company), being a corporation incorporated and registered under the laws of the State of New Jersey, in the United States of America, which company is hereinafter referred as to *The American company*, of the second part, and the Oceanic Steam Navigation Company Limited; Frederick Leyland & Company (1900), Limited; the British and North Atlantic Steam Navigation Company Limited; the Mississippi and Dominion Steamship Company Limited; the Atlantic Transport Company Limited, and the International Navigation Company Limited of the third part.

WHEREAS, the party of the second part owns a controlling interest in the shares of the International Navigation Company Limited, which owns a majority of the shares of the other companies parties of the third part;

And Whereas the term *the association* hereinafter used means the parties hereto of the second and third parts, and also includes any other company, corporate or unincorporate, partnership, body, or person, whether British, American, or other foreign, which by any arrangement is admitted to or brought under the control of the association or any of its constituent parts for the time being;

And Whereas the parties hereto of the third part are hereinafter referred to as *the British companies included in the association;*

And Whereas in the month of September, 1902, an agreement substantially to the effect of the provisions hereinafter contained was negotiated and made by and between his Majesty's Government and the American company, acting on behalf of the association;

And Whereas it is considered desirable that such agreement as last aforesaid shall be embodied in a formal instrument, to be executed not only by the American Company, but also by the British companies included in the association;

Now, these presents witness that in consideration of the stipulations hereinafter contained on the part of the American company and the British companies included in the association, the parties of the first part hereby undertake as follows:

1. The British companies included in the association shall, so long as the stipulations on their part and on the part of the American company hereinafter contained are duly observed, continue to be treated as heretofore on the same footing of general equality with other British companies in respect of any services, naval, military, or postal, which his Majesty's Government may desire to have rendered by the British mercantile marine; provided that nothing in this agreement contained shall extend to vessels of uncommercial speed which his Majesty's Government may specially require to be constructed and which are primarily designed for service in time of war.

And these presents also witness that in consideration of the undertaking hereinbefore contained on the part of the parties hereto of the first part and the American company and the British companies included in the association hereby agree as follows:

2. The British companies included in the association shall be and continue to be British companies, qualified to own British ships, and a majority at least of their directors shall be British subjects.

3. No British ship in the association, nor any ship which may hereafter be built or otherwise acquired for any British company included in the association, shall be transferred to a foreign registry (without the written consent of the president of the Board of Trade, which shall not be unreasonably withheld) nor be, nor remain upon a foreign registry. Nothing shall be otherwise done, whereby any such ship would lose its British registry or its right to fly the British flag.

4. British ships in the association, and ships that may hereafter be built or otherwise acquired for any British company included in the associaton, shall be officered by British subjects, and as regards their crews shall carry the same proportional number of British sailors of all classes as his Majesty's Government may prescribe or arrange for in the case of any other British line engaged in the same trades.

5. Subject to the existing agreement between the Admiralty and the Oceanic Steam Navigation Company Limited, and without prejudice to the provisions therein contained; the American company and any British company included in the association shall sell, or let, or hire at any time during the continuance of this agreement to the Admiralty, when required to do so by the Admiralty, any British ship in the association; and any ship hereafter to be built or otherwise acquired for any British company included in the association which the Admiralty may from time to time select. The terms of purchase or hire, if not otherwise agreed on, shall be similar to those contained in the existing agreement aforesaid.

6. At least a moiety of the tonnage built and at least a moiety of the tonnage otherwise, acquired for the association in each successive period of three years (commencing from the date of this agreement), including a reasonable proportion of the faster classes of vessels, shall be built or acquired, as the case may be, for British companies included in the association and shall be registered as British ships. There shall not be reckoned in acertaining the moiety of the tonnage so built or otherwise acquired; (a) vessels of the exceptional class referred to in article 1, which may be constructed by special arrangement with the Government of the United States of America; (b) any vessels not already in the association purchased for the association from owners other than British subjects or American citizens or subjects or companies or bodies subject to a British or American jurisdiction, provided that such last-mentioned vessels are existing ships which have been running for at least two years prior to the contract for purchase, and have not been built or acquired directly or indirectly for the association.

7. If at any time hereafter, any British company (not being a party hereto), or any British partnership, body, or person, shall be admitted to or brought under the control of the association or any of its constituent parts for the time being, then, and in every such case, subject and without prejudice to any agreement then existing between such company, partnership body, or person and his Majesty's Government, and subject and without prejudice to any agreement which may be made in view of such admission or inclusion between the American company, or other person or body acting for the association, on the one hand, and his Majesty's Government on the other hand, all the provisions of these presents shall inure for the benefit of and bind such company, partnership, body, or person, as the case may be, in like manner as if such company, partnership, body, or person, had been a party hereto of the third part, and had been comprised in the expression "The British companies included in the association," as used in this agreement, and, except with the consent of his Majesty's Government, no such British company, partnership, body, or person as aforesaid shall be admitted to or brought under the control of the association or any of its constituent parts for the time being otherwise than upon the terms specified in this clause.

8. If at any time hereafter during the continuance of this agreement any other company, whether corporate or unincorporate, partnership, body, or person, whether British, American, or other foreign, shall be admitted to or brought under the control of the association or any of its constituent parts for the time being, the association shall give notice thereof to his Majesty's Government, and shall furnish all such particulars with regard to terms, parties, or otherwise as the Government may reasonably require.

9. The American company and the British companies included in the association and any British company, partnership, body, or person hereafter admitted to or brought under the control of the association, or any of its constituent parts, for the time being, will forthwith and from time to time do and cause to be done all such further acts, and execute or cause to be executed all such further documents, and take all such steps as may be necessary to give full legal and binding effect to this agreement.

And these presents lastly witness that it is hereby mutually agreed as follows:

10. This agreement shall have effect for twenty years from the 27th September, 1902, and shall continue in force thereafter subject to a notice of five years on either side (which may be given during the continuance of this agreement) provided that his Majesty's Government shall have the right to terminate this agreement at any time if the association pursue a

policy injurious to the interest of the British mercantile marine or of British trade.

11. This agreement shall be construed and take effect as a contract made in England and in accordance with the law of England. The American company hereby irrevocably appoints the chairman for the time being of the British committee of the association, for if there be no such chairman, then each and every British company in the association to be the agent or agents in England of the American company, for the purpose of accepting service on behalf of the American company of any process, notice, or other document in respect of any matter arising out of this agreement; and service of any such process, notice, or document on such chairman or company as aforesaid shall be deemed to be good service on the American company. Any notice or document sent by registered post addressed to the American company at No. 22 Old Broad Street, London, or to the register office of any British company in the association, shall also be deemed to have been duly served on the American company.

12. In case of any difference as to the intent and meaning of this agreement, or in case of any dispute arising out of this agreement the same shall be referred to the Lord High Chancellor of Great Britain for the time being, whose decision, whether on law or fact, shall be final.

As witness the hands and seals of two of the before-mentioned commissioners and the seal of the board of trade, parties hereto of the first part, and the corporate seals of the parties hereto of the second and third parts.

Signed, sealed, and delivered by Admiral Walter T. Kerr, G. C. B., and Rear-Admiral W. H. May, M. V. O., being two of the commissioners for executing the office of lord high admiral of the United Kingdom of Great Britain and Ireland in the presence of:

Walter T. Kerr (L. S.)
W. H. May (L. S.)

William G. Perrin,
Admiralty clerk.

The seal of the Board of Trade was hereunto affixed by the direction of the president of the Board of Trade in the presence of—

G. W. Balfour (Seal of the Board of Trade.)

R. J. Lister,
Board of Trade librarian.

The seal of the International Mercantile Marine Company was hereunto affixed in the presence of—

C. E. Dawkins, director. (Seal of the International
C. R. Jeeves, assistant secretary. Mercantile Marine Company.)

The common seal of the Oceanic Steam Navigation Company, Limited, was affixed in the presence of—

S. Bruce Ismay, director. (Seal of the Oceanic Steam
James C. Farrier, secretary. Navigation Company, Limited.)

The seal of Frederick Leyland & Company (1,900), Limited, was hereunto affixed in the presence of—

A. Stephens, secretary. Hy. Wilding, Walter Glynn, directors. (Seal of Frederick Leyland & Company (1,900), Limited.)

The seal of the British and North Atlantic Steam Navigation Company, Limited, was hereunto affixed in the presence of—

Wm. J. Edwards, secretary. Hy. Wilding, David Richards, directors. (Seal of British and North Atlantic Steam Navigation Company, Limited.)

The seal of the Mississippi and Dominion Steamship Company, Limited, was hereunto affixed in the presence of—

Wm. J. Edwards, secretary. Hy. Wilding, David Richards, directors. (Seal of the Mississippi and Dominion Steamship Company, Limited.)

Signed pursuant to resolution of the board.

Arthur A. Hillen, secretary. Charles F. Terrey, Fred W. May, directors. (Seal of the Atlantic Transport Company, Limited.)

The seal of the International Navigation Company, Limited, was hereunto affixed in the presence of—

H. Pearce, secretary. Hy. Wilding, John E. Willett, directors. (Seal of the International Navigation Company, Limited.)

Senator Jones declared that because the International Mercantile Marine owns the American Line which flies the American flag, in addition to its regular fleet, controls approximately forty vessels leased from the Shipping Board, all of the ships are subject to the terms of the contract and therefore are actually operated in the interest of the British Government and British trade. As the British shipping center is in New York, Senator Jones said, the British shipping men are in accord with the eastern trunk lines which seek to cancel the present equalization of export freight rates from Central Freight Association territory to Gulf and South Atlantic ports.

"The present equalization, for the first time," said Senator Jones, "establishes the principle that American foreign commerce may best be developed and extended by the establishment of new foreign trade routes by the United States Shipping Board, and in furtherance of this movement that every American export shipper should have the right, without discrimination by the railroads, to choose the port through which his business can be handled most expeditiously and economically."

P. A. S. Franklin Makes Statement

Following the address of Senator Jones, P. A. S. Franklin, president of the International Mercantile Marine Company, rose and asked Senator Ransdell, president of the Association, for a moment to reply during the presence of Senator Jones.

"As for the International Mercantile Marine Company, the Senator is unfair to us. All of these agreements to which he refers have been before the Shipping Board and have been approved. Judge Payne, when he was chairman of the Board, passed upon them and said they were quite satisfactory.

"If you will read these documents in view of the fact that the company owns large British property, you will find that there is also an unusually large protection for American interests.

"Let me recall also that at one time we had our British property sold to British subjects. We were about to close the deal when the President of the United States asked us not to consummate it. Our object was to get money for investment in American ships. Do we get no credit for what we have done? Moreover we are the only company which have brought over vessels from the British flag to American registry.

"It is very unfair for a Senator of the United States to get up here before this association and make an incorrect statement. Under the British law any tonnage owned by a foreign corporation and operated under the British flag must be maintained at the same strength as when it was taken over or it is subject to confiscation.

"The International Mercantile Marine is absolutely American. There are none but Americans on its board of directors. More than ninety percent of our shares are owned by Americans. We have invested in American shipping, vessels obtained from the Shipping Board. We have transferred a 16,000-ton ship from the British to the American flag. When the country entered the war and ships were requisitioned, we were the first company to sign the requisition order."

Admiral W. S. Benson

Admiral Benson, chairman of the United States Shipping Board, prefaced his remarks with a statement that he did not know until a couple of days ago of the agreement entered into between the British Government and the International Mercantile Marine Company, that he was not in sympathy with it, and that as chairman of the Shipping Board he would begin an investigation. He said that the American merchant marine must be 100 percent American and warned against insidious attacks from foreign sources.

"Despite proposals that the United States withdraw from the shipping business," declared Admiral Benson, "the Shipping Board is solemnly charged by the law of the land to establish a permanent merchant marine for the country. Consequently, it was said, the Board must conform to the Shipping Act so as to provide for an American permanent merchant marine, under private ownership sufficient to carry the greater part of our commerce."

Services rendered the country's foreign commerce by an adequate merchant marine were illustrated by Admiral Benson in comparing the percentage of American commerce carried in American bottoms at present with preceding periods. Foreign commerce of the country carried in American flag ships in 1920, was estimated by Admiral Benson at 42.7 percent, the remaining 57.3 percent being carried in foreign bottoms. In comparison, Admiral Benson showed that prior to the war, taking 1910 as a typical year, American foreign commerce carried in American vessels totalled only nine percent, the remainder carried wholly by foreign ships.

Admiral Benson defended the sale price policy of the Shipping Board pursued in the sale of the Government owned merchant ships to private interests. The Shipping Board, he said, must move slowly in anything it does in connection with changes in the sale policy now in force, "for this policy was determined with all these things laid down by law in mind."

Matthew Hale

Matthew Hale, president of the South Atlantic States Association, stated that the Merchant Marine Act contained two most important policies—self-defense and the encouragement of foreign commerce. He stated that foreign commerce must be developed in the interests of the shippers rather than the shipowners. The men in the interior must be able to sell their products and the Government should give its co-operation from the factory to the consumer.

Mr. Hale pointed out that, if each port would build up a foreign trade for the production of its own back country, the number of people interested in shipping would be greatly increased and that it would then be much easier to get people to invest in ships. He attacked the concentration of export shipments through the single port of New York and declared that a change must be made to provide new outlets to foreign markets. New export ports should be established on the South Atlantic and Gulf coasts, and the export rail rates to these ports should be kept equitable.

William E. Humphrey

Former Congressman Humphrey of Washington urged the repeal of Panama Canal tolls on American vessels. He stated that no one thing would do so much to increase the trade of the Pacific coast as the repeal of these tolls and that every toll levied on American ships passing through the canal is a direct tax on our commerce.

Mr. Humphrey claimed that giving free passage to American ships would not violate any treaty obligations because America had acquired title to the land upon which the canal is constructed, has done all the work and paid all expenses and has relieved England of all responsibility for construction and maintenance so that the Hay-Pauncefote treaty had no application in law or equity to this matter.

J. W. Powell

J. W. Powell, vice-president of the Bethlehem Shipbuilding Corporation, stated that American shipbuilding and shipowning will live or die together. In regard to shipbuilding he declared that even with superior American efficiency and possible lower cost of certain materials, the future of the industry depended upon some sort of assistance from the Government, such as is extended to other business by the tariff.

In speaking of the problems facing the shipbuilder, Mr. Powell stated that in ship construction it is estimated that 40 percent is labor, 40 percent materials and 20 percent overhead. Shipbuilding is not manufacturing, but assembling and building in which hand labor takes the largest part and this fact makes competition with foreign labor more severe.

Commenting upon the assistance needed by the shipbuilders, Mr. Powell said: "The Merchant Marine Act of 1920 has all the means necessary to accomplish that result. It is useless to talk of more legislation until the Act is tested. It is necessary to have appointed a real Board that will command the respect of the American people. In saying this, I do not intend to depreciate the present Board, but it is understood that the existing commissioners will not be confirmed and I am speaking of the new members to be named. The Shipping Board and the Emergency Fleet Corporation should be separated and the Board allowed to attend to its duty as a regulatory body and not to devote its time to shaking over the bones of the dead past.

Commander R. D. Gatewood

Commander Gatewood, director of the division of construction and repair, Emergency Fleet Corporation, asked for the co-operation of the shipping interests of the country with the Shipping Board in curtailing operating and repair expenses to a minimum. He stated that the bill for repair work alone had amounted to $75,000,000 per annum divided as follows: 10 percent abroad, 10 percent in navy yards and 80 percent in home yards.

Commander Gatewood advocated a policy of no alterations on government ships and no repairs abroad except in case of emergencies. He declared that the ship's forces should make all possible repairs and that while he had reduced the repair bill to about $4,500,000 per month, it could be still further reduced.

Homer L. Ferguson

Homer L. Ferguson, president of the Newport News Shipbuilding & Dry Dock Company, pleaded for government protection for the shipping industry, declaring that some form of subsidy or preferential treatment must be given the merchant marine. "It is unfortunate," said Mr. Ferguson, "that the President should have cast out the crux of the Merchant Marine Act, Section 34, which directs the abrogation of commercial treaties. In my humble judgment he should have executed the law. To say that discriminatory duties will lead to recrimination and retaliation may be true, but remember this, other nations cannot discriminate against us in trades in which they have no part. In the first six months of 1920 in trade with Great Britain we carried 12 percent of our imports and 25 percent of our exports. It does not seem that we have too many ships in that trade.

"The objection of a plain subsidy," said Mr. Ferguson, "is that it must be re-enacted each year and thus become the football of politics. Whatever scheme is devised should have the elements of permanence. We must have a policy that we can tie to as it takes time to build a merchant marine and a seafaring nation."

P. A. S. Franklin

P. A. S. Franklin, president of the International Mercantile Marine Company, said that until the shipping business is put on sound lines by the Government and a fixed policy regarding the position of private owners in permanent routes is established, it is my opinion that nothing can be accomplished in the way of selling these steamers in any large numbers and properly establishing American corporations in the foreign trades of the world.

Recommendations made by Mr. Franklin were that the Shipping Board establish mail, passenger and cargo routes, carrying proper compensation for operating companies with the object of inducing private owners to buy the steamers and maintain the various trade routes.

That the United States should be divided into three sections, North Atlantic, South Atlantic and Gulf, and Pacific Coast, possibly North and South, for the development of trade routes; only companies and individuals who have demonstrated their ability to operate ships satisfactorily should be selected by the Shipping Board as operators; giving preference to private owners now in such trade routes, or who have purchased Government ships, and that only one firm should operate Government tonnage in a given route.

That a careful survey be made of the Government-owned tonnage to determine which is most suitable for the mail, passenger and cargo routes to be established, reserving the remaining tonnage for bulk cargo and tramp usage not competing with private lines.

That operating companies enter into conference agreements as to rates, etc., for the account of the Shipping Board, and ships withdrawn from one trade and placed in another, dependent upon the movement of traffic in the various routes.

That the operating companies have the option of purchasing the steamers in service at the price at which the Shipping Board at that time is selling, and in case of purchase, the

(*Continued on page* 166)

New York Marine Exposition Stimulates Interest in Shipbuilding and Shipping

Unusual Exhibits Draw Crowds at Second Exposition in New York Under Auspices of National Marine League

THE third National Marine Exposition opened in Grand Central Palace, New York City, at 2 P. M., Monday, January 24. American shipping, American ship operation and American appliances and inventions were displayed on the main and mezzanine floors of the Palace in what was considered one of the most elaborate and comprehensive marine exhibitions ever placed before the public, continuing from the opening hour on Monday until Saturday, January 29.

Opening Ceremonies

In the absence of President-elect Warren G. Harding, who was unable to be present, President H. H. Merrick, of the Mississippi Valley Association, delivered the opening address, which was responded to by P. H. W. Ross, president of the National Marine League of the United States, the organization which sponsored the exhibition. An honor guard of sixty uniformed men from the schoolship *Newport,* under Captain Bayliss, acted as escort to Mr. Merrick for the opening ceremonies.

A feature of "Marine Week" was the singing of chanteys by a dozen or more old sailors from Sailors' Snug Harbor. These old men recalled to the present age the days of sixty years ago when America was foremost in the world's maritime trade. Many of the old-timers are over eighty years old and some of the songs they sang were known to few of the men who follow the sea at present.

Programme of the Week

Although no set programme was arranged for the week, each day was set aside for a special occasion. Monday, the opening day, was designated as Officials' Day, when the officers of the League were on hand for participation in the opening ceremonies and inspection of the exhibits.

Tuesday was National Marine League Day, and in the evening the League held its ninth annual banquet at the Hotel Commodore. Among the prominent shipping men and speakers attending the dinner were the following:

Guests at the Banquet

August Belmont, chairman, board of trustees of the National Marine League; Frank C. Munson, president of the Munson Steamship Lines and a trustee of the National Marine League; Honorable William M. Calder, United States Senator from New York state; George J. Baldwin, president of the American International Corporation; P. A. S. Franklin, president of the International Mercantile Marine Corporation; W. Averill Harriman, chairman of the board of directors of the United American Lines, Inc.; William L. Todd, L.L.D., president of the Todd Shipyards Corporation; Oscar L. Gubelman, of Knauth, Nachod & Kuhne, and a trustee of the League; Captain Kermit Roosevelt, president of the recently organized Roosevelt Steamship Company. Senator W. L. Jones, author of the Merchant Marine Act, was unable to be present.

Wednesday was set aside as Engineers' Day; Thursday, Society Day; Friday, Mercantile Marine Day, and Saturday, Old Salts' Day.

Moving Pictures and Lectures

An afternoon and evening motion picture schedule was arranged for each day of the show, in many cases lectures and slides being used by the exhibitors. The schedule included the following:

Wilson Welder & Metals Company, lecture and slides; National Life Preserver Company, motion pictures of life preserver suits; Ocean Marine Engineers' Beneficial Association, No. 80, address "Ocean Marine Engineers"; Submarine Boat Corporation, shipbuilding and shipping film; Babcock & Wilcox Company, "Seamless Tubes"; General Electric Company, "The Queen of the Waves" and "Revelations"; Columbian Rope Company; Sperry Gyroscope Company; Baltimore Dry Docks & Shipbuilding Company; International Mercantile Marine Lines, "S. S. *Olympic*" and "Under the Eagle's Wing"; Submarine Signal Company; Mitchell Ship Salvage Company, "The Newest Salvage"; Plymouth Cordage Company, "The Story of Rope."

Everything pertaining to ships and shipbuilding, marine inventions and ship operation was on exhibition, nearly 200 exhibitors being listed.

The next show, officials of the League announced, will be held about the first of May at New Orleans, La.

EXHIBITS AT NEW YORK MARINE EXPOSITION

Alberger Pump & Condenser Company, 140 Cedar Street, New York.—2,000-horsepower Alberger occluder for removing air from surface condensers; 35-horsepower auxiliary impulse turbine; feed water heater; high and low pressure expansion joints.

Aluminum Cooking Utensil Company, New Kensington, Pa.—"Wearever" aluminum wear.

American Balsa Company, 50 East 42d street, New York.—Section of a ship's deck upon which was mounted a set of Welin quadrant davits and Lundin standard lifeboats nested, davits fitted with non-toppling falls; sectional models showing typical Balsa wood insulation for refrigerator space aboard ship; new type of releasing gear for collapsible boats and a cabinet of miniature lifeboats and rafts and working models of davits, cranes, etc.; Balsa wood liferafts; surf boards and horseshoe life chairs; lifeboat winch and photographs of typical Balsa insulation and Welin davit and lifeboat installations.

American Blower Company, Detroit, Mich.—No. 5 Sirocco fan; 4-inch by 4-inch vertical steam engine; two small Sirocco utility ventilating sets; equipment for heating, lighting, ventilation and mechanical draft.

American Car & Foundry Company, 165 Broadway, New York.—Single electrode, single bolt heater with capacity of 60 bolts per hour; two electrode and three electrode rivet heaters having capacities of 200 and 300 rivets per hour respectively (all machines in operation).

American Chain Company, Inc., New York.—Chain, anchor chain and welding rods.

American Chain Ladder Company, 30 East 42d street, New York.—Chain ladders.

American Engineering Company, The, Philadelphia, Pa.—Steam windlasses and electro-hydraulic steering gear, also special Hele-Shaw pump; model of new type electric winch operated in conjunction with a model mast and boom arrangement; steering wheels and hand operated capstan.

American Manganese Bronze Company, Philadelphia, Pa.—Manganese bronze propeller blade, forged and bent while hot to demonstrate that a deformed blade can be restored by hot forging; 8-ton Y-casting for the Gilboa Dam, 42 inches by 30 inches by 30 inches, for the New York Board of Water Supply; semi-steel propeller blade broken under 50,000-pound load and manganese bronze blade which took a permanent set of ¼ inch under 60,000-pound load and blade of high tensile bronze which took a set of ¼ inch under 100,000-pound load; dry sand cast blade of metal melted in this company's electric appliances; high test manganese bronze rods; copper castings for switchboard work and a manganese bronze propeller blade from a 17-foot diameter wheel furnished the Merchant Shipbuilding Corporation; Hall bronze lifeline-throwing gun.

American Manufacturing Company, Brooklyn, N. Y.—Background occupied by painting of plant; coil of 10-inch bolt rope with red marker; pyramid of rope graduated from 18 inches down to ¼-inch diameter; samples of ratline, marline, hawsline and spun yarn; marine oakum; a length of bolt rope with Tuxpam gem applied to one end and a Turk's head at the other.

American Seamen's Friend Society, New York.—Library that was on Commander Peary's ship, the *Roosevelt;* colored slides of sea life, etc.

American Society of Marine Draftsmen, Philadelphia, Pa.—Blue prints and small drawing table.

American Steel Foundries, 30 Church street, New York.—Models and specimens of Dunn stockless anchors; model of new type anchor equipped with lock grip.

Asbestolith Manufacturing Company, 1 Madison avenue, New York.—Samples of Asbestolith ship decking with section cut away; samples of material applied to wood floors and stairways and to wooden decks.

Ashton Valve Company, Boston, Mass.—Gages, safety valves, gage testers, large steamship whistles.

Atlas Soot Blower Company, New York.—Soot blower.

Audel, Theo., & Company, 72 Fifth avenue, New York.—Books on marine and electrical engineering and naval architecture.

Babcock & Wilcox Company, 85 Liberty street, New York.—Moving pictures of the Pittsburgh Seamless Tube Company, showing manufacture of tubing; a full-sized sectional model of a B. & W. marine boiler; a full-sized sectional model of a B. & W. express type naval boiler; electric concentration indicator; boiler fittings; the first and the latest B. & W. oil burner installations; tractorscope showing slides of B. & W. installations; photographs of vessels equipped with B. & W. products, the new B. & W. oil separator and several performance charts.

Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md.—Bow of ship with full crew of riveters at work, showing fitting up and riveting of a steel plate; model of 10,300-ton deadweight oil tanker; photographs of the plant.

Beaver Tile & Specialty Company, 442 West 42d street, New York.—Samples of colored cork tile and natural cork tile for floor.

Benjamin Electric Manufacturing Company, New York.—Telltale board in operation, watertight valves submerged in water, standard marine panel boards and fittings and standard lighting fixtures.

Benson Electric Company, Superior, Wis.—Electric control for steering gear; electric flash light signal for mast head.

Bethlehem Shipbuilding Corporation, Bethlehem, Pa.—First Weir feed water pump built in America exhibited (all American rights for Weir apparatus controlled by Bethlehem Shipbuilding Corporation, Ltd.); two Bethlehem-Weir fuel oil service pumps; Bethlehem duplex ram hydraulic telemotor set up for operation; sections of castings used in Weir pumps; Bethlehem-Dahl mechanical oil burning system; model of 12,500-ton deadweight oil tanker; display board showing parts used in Curtis turbines; models showing the features of each of the eight Bethlehem plants; samples of various types of ship fittings.

Bowman-Edson, M. K., Company, 65-67 Dey street, New York.—Model of bullet tube brush.

Boucher, H. E., Mfg. Company, 150 Lafayette street, New York.—Model of sulphur steamer *Herman Frasch;* schooner model; working models of yachts and power boats; miniature engines and boilers for experimental and demonstrating purposes; collection of standard fittings for ship models; model of commissary department on board battleship, made to ½-inch scale, showing galleys, messrooms, storerooms, etc.

Brown, A. Judson, & Company, 30 Church street, New York.—Chains and anchors.

Brunswick Refrigerating Company, New Brunswick, N. J.—Two-ton steam driven compressor with high pressure side completely connected; 8-ton compressor driven by piston valve steam engine; ¼-ton compressor with cylinder cut away to show moving parts. Exhibit of small parts used in Brunswick apparatus; 40-gallon scuttle butt or water cooler; 250-pound marine ice making set; 12-foot by 7-foot by 8-foot refrigerator with side cut away to show details of insulation and piping, etc.

Buzzini, Walter J., Inc., 505 West 21st street, New York.—Steam table, steamers, kitchen equipment.

Car Heating & Lighting Company, The, New York.—Electric heaters.

Coen Company, 50 Church street, New York.—Oil burning installation; pumping and heating outfit and firing fronts.

Columbian Bronze Corporation, 522 Fifth avenue, New York.—Bronze propellers.

Columbian Rope Company, Auburn, N. Y.—Large coil of 10-inch bolt rope; coils of smaller rope; display board of knots and splices; red, white and blue Columbian marker in silk displayed in background of booth; moving pictures showing the manufacture of Columbian rope.

Consolidated Shipbuilding Company, Morris Heights, New York.—Model of shipyard and small gasoline engine.

Cornell-Emery Company, 25 West Broadway, New York.—Color designs of saloon, smoking hall, reception hall and bedroom of first class passenger ship; portable combination settee which is convertible into upper and lower berths; display of high grade furniture for steamships, including English oak burle veneer table with inlay of walnut butt; walnut smoking room table with carved base; oak burle veneer cabinet; various types of chairs; collection of French Wilton rugs; model of first class suite; samples of carpet and linen; 2-ton carbon dioxide refrigerating machine.

Cory & Son, Inc., Charles, 290 Hudson street, New York.—Mechanical and electrical telegraphs, loud speaking telephones, voice tube apparatus complete; watertight and non-watertight fixtures; mechanical telegraph accessories; electric bells, buzzers, signaling apparatus; switches, plugs, receptacles; rudder angle indicators; navigator log, steering mechanism locking device, etc.

Crane Company, Chicago, Ill.—Valves and fittings; sectional models of various valves; complete model ship bathroom.

Crane Packing Company, Chicago, Ill.—Flexible metallic packing.

Cutting & Washington Radio Corporation, 6 West 48th street, New York.—Full size model of a radio room fully equipped; small gas driven generator set for home use and a radio transmitter.

Cutler Hammer Manufacturing Company, Milwaukee, Wis.—Capstan equipment, consisting of 45-horsepower motor with complete controlling equipment of contactor type; 3-horsepower steering gear control; photographs of 300-horsepower steering gear equipment; photographs of winch control, hydro-electric steering gear control, submarine control types of all kinds, etc.; 1,000- and 2,000-watt portable type ship air heaters.

Davidson Company, M. T., New York.—Vertical boiler feed pump and hydraulic ash ejector.

Debevoise Company, Brooklyn, N. Y.—Marine paints and "Dereka" metal paints.

DeLaval Separator Company, 165 Broadway, New York.—Oil purifier demonstrated in connection with a cruising gear, capacity 125 gallons per hour; steam and motor driven oil purifiers for central station and other power station work; smaller motor and steam driven purifiers for marine installations; samples of oil before and after passing through centrifugal separator.

DeLaval Steam Turbine Company, Trenton, N. J.—3,500-horsepower compound marine turbine set with high and low pressure turbine rotors shown with high speed reduction gears and low speed pinions; small cruising turbine with gravity oil system and oil purifier in operation; 10-kilowatt turbine driven generator; sectionalized 1½-horsepower lighting set with turbine speed of 50,000 revolutions per minute at turbine shaft and gear reduction 10 to 1.

Devoe & Reynolds Company, 101 Fulton street, New York.—Marine paints and varnishes.

Donnelly, William T., 17 Battery Place, New York.—Model of floating dry dock and models of barges.

Duparquet, Huot, Moneuse & Company, New York.—Electric stoves, ranges, urns, etc.

Durkee, Chas. H., & Company, New York.—Marine hardware, sounding machine, binnacle.

Durkee Manufacturing Company, Inc., New York.—Marine compasses and magnetic testing equipment.

Edson Manufacturing Company, Boston, Mass.—Diaphragm bilge pumps hand and power operated, new type diaphragms, steering gears and wheels, port lights.

Egan Corporation, K. Francis X., 22 Bergen street, Brooklyn, N. Y.—Cotton waste.

Electric Arc Cutting & Welding Company, Newark, N. J.—Portable arc welding machine; exhibition of welding within a steel cage seen through a dark glass window.

Electrose Mfg. Company, Brooklyn, N. Y.—"Arcover" insulators, wall bushings and insulated connectors, insulating knobs, handles, sheets, tubes, etc.; insulated turnbuckles, special forms of trolley wire suspension insulators, etc., distributor blocks, disks, switch bases and the like.

Estate of Adolph Starke, Brooklyn, N. Y.—Bolts, spikes, rivets, ventilator cowls, concrete inserts.

Fairbanks, Morse & Company, 30 Church street, New York.—100-horsepower oil engine; ½-ton ice plant; 1½-horsepower house and boat lighting set.

Federal Bending Machine Company, Bayonne, N. J.—Machine for bending pipe cold; samples of bent pipe.

Fire Detecting Wire Corporation, New York.—Fire detecting system.

Foster Marine Equipment Company, New York.—Superheater; photographs of ships equipped with Foster boilers and superheaters.

Fougera & Company, E., 90-92 Beekman street, New York.—Fino cream soap.

Fuller Company, George A., Wilmington, N. C.

General Electric Company, Schenectady, N. Y.—Working model of steam turbine electric drive installation connected to an actual ship control panel; rotating element of 2,500-horsepower turbine except the low speed gear; spring type thrust bearing; deck winch motor; two engine room motors for operating auxiliaries; one 4-kilowatt arc welding set; a 10-horsepower steam generating set with marine type switchboard; three 18-inch searchlights; running light telltale board with running lights; blinker key and light set; two marine type fans; two display boards, one with merchant marine cables and one with rotating turbine buckets. The entire display is actually operated except the turbine and deck winch motor.

Gillespie & Sons, Charles H., Jersey City, N. J.—Varnishes and enamels.

Globe Shipbuilding & Dry Dock Company, Baltimore, Md.

Gold Car Heating & Lighting Company, New York.—Electric heaters.

Goodrich Transit Company, Chicago, Ill.—Model of passenger steamer *Alabama.*

Gregory Galvanizing Works, Thomas, Brooklyn, N. Y.—Galvanized ship parts and fittings, including cowls, hand rails, shackles, small anchors, blocks, chain, cleats, chocks, spikes, etc.

Griscom-Russell Company, 90 West street, New York.—Reilly submerged type self-scaling evaporator, Reilly distiller, Reilly aerating filter, Reilly fuel oil heater, Reilly feed water heaters, multiwhirl oil cooler, G.R. strainers, G-R multiscreen grease extractor, Stratton separators, back pressure and by-pass valves, complete evaporating plant with all accessories piped up for operation.

Guarantee Exterminating Company, 400 Fifth avenue, New York.—Masks used in fumigating ships, literature, etc.

Hamlin Peeling Machine Company, 430 Eleventh avenue, New York.—Vegetable peeling machine.

Hamilton & Hansell, Inc., New York, and Superior Engineering Company, 15 Park Row, New York.—Sal-log, apparatus for giving the speed of ships by means of pitot tubes; liquid carbonic acid fire extinguishing system; Superior soot blower.

Hansen & Yorke Company, Inc., 88 Warren street, New York.—Quinn oil torches and burners, special machine bolts of all types, ship fittings, Yale & Towne blocks and hoists of all types up to 10 tons, and trolleys, diaphragm pumps and engine.

Hartmann, Charles, Company, 977-991 Dean street, Brooklyn, N. Y.—Model of midship portion of passenger vessel showing ventilation system for quarters.

Horne Manufacturing Company, Jersey City, N. J.—Watertight electrical fixtures, ship telegraphs, automatic running light indicator, cargo reflectors, voice tubes, Magnavox anti-noise marine telephone.

Hush, H. J. 36 West 60th street, New York.—Small gasoline engines driving winches, pumps and motorboats.

Hyde Windlass Company, Bath, Me.—Brown steam tiller; hydro-electric steering gear with telemotor and hand attachments; two 3,000-pound manganese bronze propeller blades and a number of smaller wheels including their stock wheel that drove the *Miss America* 77.83 miles per hour—the world's speed record.

Industrial Management, New York.

International Mercantile Marine Company, 9 Broadway, New York.—Nineteen-foot model of steamship *Olympic;* painting showing sectional view of *Olympic;* marine paintings of ships in the I. M. M. service leaving New York, in mid ocean, and nearing England.

International Nickel Company, The, 43 Exchange Place, New York.—Nickel, monel metal castings, rods, wire, forgings, blades for General Electric and DeLaval turbines and monel metal as used in Crane, Jenkins, Chapman and other types of valves.

Irving Iron Works, Long Island City, New York.—Section of platform and ship walkway of Irving subway treads and grating.

Jahncke Dry Dock & Ship Repair Company, New Orleans.—Photographs of plant and products.

Johnson, M. E., Inc., Edes, New York.—*Johnson's Steam Vessels.*

Kahnweiler's Sons, David, 260 Front street, New York.—Life saving equipment, jackets, life savers, models of lifeboats and rafts, cork fenders and gun.

Kelley Industrial Corporation, 37 Maiden Lane, N. Y.—Harrison emergency tube plug for Scotch boilers, Hodgson safety plug for watertube boilers.

Kinney Manufacturing Company, Boston, Mass.—Model of rotary plunger pump; pumps for handling heavy viscous products.

Locomotive Superheater Company, 30 Church Street, New York.—Section of marine firetube superheater; sectional model of Scotch boiler with superheater applied; display board of forged return bends; steam pipe heating coils showing application of forged return bends; feed water heater pump; electric pyrometer for temperatures up to 800 degrees F.; photographs of suerheaters applied to marine and stationary uses.

Long Island Soap Company, The, Brooklyn, N. Y.—Soap, metal polish and cleaning compounds.

Lord Dry Dock Corporation, 105 West 40th Street, New York.—Sketches of West New York and Providence, R. I., ship repair plants, model of 10,000-ton floating dry dock with U. S. S. *Oregon* in the dock, model of full rigged ship.

Luckenbach Steamship Company, 44 Whitehall Street, New York.—Sectional model of S. S. *Lewis Luckenbach;* model of new Weehawken, N. J. terminals; paintings of S. S. *Pleiades* and *Edward Luckenbach.*

Lunkenheimer Company, Cincinnati, O.—Valves, oil cups and grease cups.

McDougall, Alexander, Duluth, Minn.—Model of a canal-size ocean steamer, also model of the *Christopher Columbus;* model of a full-rigged sailing vessel and a model of a proposed seagoing canal boat; model of a rectangular passenger vessel and a tank for testing these models.

Mack Engineering & Supply Company, 123 Liberty Street, New York.—Firebrick and furnace linings.

Mallory Industries, Inc., 42 Broadway, New York.—Independent Wireless Telegraph Company, a subsidiary, exhibited a modern ship radio installation including high power and low power sets for long and moderate range communication, high power set with 5-kilowatt arc and 1-kilowatt spark; various other types of radio equipment shown. Crystal division of the Mallory Industries exhibited washing machines.

Marine Canvas Supply Company, Pier 7, North River, New York.—Canvas and rope cargo nets; rope ladders, canvas bags, flags.

Marine Decking & Supply Company, Philadelphia, Pa.—Lit-O-Sil-O decking, Madesco marine paints (demonstration of painting steel under water), Madesco solution, Madesco tackle blocks, model of section of S. S. *Charles H. Cramp* equipped with Madesco blocks.

Marine Journal, The, 17 State street, New York.

Marine Review, The, Cleveland, Ohio.

Marine Works, Inc., The, 3 Coenties Slip, New York.—Kitchen equipment, cooking utensils.

Maritime Engineering and Sales Corporation—Allan Cunningham Company, Inc., 2 Rector street, New York.—Allan Cunningham 25-40-horsepower electric cargo winch; McTaggart-Scott type hydraulic telemotor; Waterbury hydraulic variable speed gear demonstrating set; Bennett flue blower and combustion chamber cleaner; "Tyfon" air siren.

Masten Company, Inc., J. H., 38 East 9th street, New York.—Life preservers, motors for small boats and small propellers.

Metal & Thermit Corporation, 120 Broadway, New York.—Section of thermit weld made on pin journal of 8½-inch diameter Diesel engine crank shaft; specimens of thermit welded pipe; lantern slides of thermit process applied to various marine welds; demonstration of thermit process to pipe welding; moving pictures of welding process applied to weld in the stern frame of steamship *Northern Pacific.*

Mitchell Ship Salvage Company, Port Jefferson, Long Island.—Photographs and literature.

Munson Steamship Line, 82 Beaver street, New York.—Models of Munson Line ships; painting of the S. S. *American Legion.*

National Hoisting Engine Company, Harrison, N. J.—Five-ton, single drum, single gear, heavy duty, electrically operated ship winch.

National Life Preserver Company, 11 Broadway, New York.—Several dummies with "Everwarm" safety suits.

National Marine League of the U. S. A.—*The National Marine.*

Nautical Gazette, The, New York.

Near East Relief, The, New York.—Literature.

Nelson's Loose-Leaf Encyclopedia.—Several sets of the encyclopedia.

Neptune Association, New York.—Painting of Neptune.

Neptunus Ship Supply Company, Inc., New York.—Erfmann boiler water controller.

New Jersey Asbestos Company, New York.—Semi-metallic packing.

New York Marine News Company, Inc., 26 Water street, New York.—*Marine News.*

New York Maritime Register, 88-90 Gold street, New York.—*Maritime Register.*

New York Engineering Company, 2 Rector street, New York.—Model of Ludlum watertube boiler of 2,250 square feet heating surface equipped with oil burners; Lowy tube cleaners; photographs of installations of Ludlum boilers.

New York State Nautical School, Training Ship *Newport,* New York.—Exhibit of knots and splices.

New York Tribune.—Ship and travel guide.

New York University, New York.—Literature regarding school of commerce, accounts and finance.

Niles, Bement, Pond Company, 111 Broadway, New York.—Gear testing machine; turbine reduction gear; types of spur gears, spiral gears and herringbone gears.

Ocean Marine Engineers' Beneficial Association, No. 80, 15 Whitehall street, New York.

Pacific Mail Steamship Company, San Francisco, Cal.—Model of 535-foot passenger vessel built by New York Shipbuilding Corporation and model of steamship *Ecuador* Background of exhibit in the form of a map illustrating the routes of the Pacific Mail Company. A house flag that has just completed a circuit of the world was also displayed.

Page Steel & Wire Company, New York.—Page ARMCO welding rods and electrodes for oxy-acetylene and electric welding of mild steel plates, structural iron and low carbon castings; water color painting showing application of Page ARMCO welding iron with the oxy-acetylene flame and the electric arc; welded samples demonstrating the toughness and ductility of the finished weld.

Pantasote Company, 11 Broadway, New York.—Full size model of a passenger stateroom furnished with "Vehisote" fiber panel.

Paige & Jones Chemical Company, 15 East 40th street, New York.—F-F-F boiler feed water treatment.

Palmer Bros. Engine Works, Cos Cob, Conn.—Gasoline engines ranging from 2½ to 50 horsepower.

Pioneer Metallic Packing Company, Brooklyn, N. Y.—Metallic packing for reciprocating engines and turbines; hydraulic packing for pump plungers.

Plymouth Cordage Company, North Plymouth, Mass.—Samples of rope and fibers for marine purposes; photographs showing details of manufacturing processes of rope for yacht work; models of the *Resolute* and *Thistle;* moving pictures of rope manufacture.

Pneumercator Company, 15 Park Row, New York.—Models of draft gages, tank gages, etc.

Pyle National Company, 30 Church street, New York.—Small turbo generators.

Quasi Arc Weldtrode Company, Inc., Brooklyn, N. Y.—Torsion testing machine; impact bending weld testing machine; portable D. C. welding outfit; belted welding generator; welding controller; welding booth for actual demonstration; samples of welded ship joints and photograph of electrically welded ship *Fullagar.*

Reid & Company, John, New York.—Sixty-inch ventilation fan operated by a 6¼-inch by 4½-inch forced lubrication enclosed engine; 7½-inch by 5-inch open type forced lubrication blower engine; 8-inch by 6-inch enclosed type forced lubrication blower engine; oil burning furnace front; sectional coal and oil burning furnace front; knockdown section of a sectional coal and oil burning furnace front; portable furnace front with removable sill, and a 7-inch by 6-inch, 110-volt, 12-kilowatt steam auxiliary lighting set.

Roberts Safety Watertube Boiler Company, Red Bank, N. J.—Small size boiler complete; front of standard boiler for seagoing steamships.

Roebling's Sons Company, John A., Trenton, N. J.—Wire, wire rope, rope fittings, safety slings, insulated wire, gas and electric welding wire, new type wire rope block designed for maximum rope wear.

Row & Davis, Engineers, Inc., 91 West street, New York.—Paracoil evaporators, heaters, coolers, feed water heaters.

Sailors' Snug Harbor, Staten Island, N. Y.—Three models of ships made by sailors at the Home; paintings of vessels.

Scovill Manufacturing Company, Waterbury, Conn.—Brass tubing, rods, wire and sheet metal, condenser tubes and brass pipe; samples of shells manufactured for allied governments during the war.

Seamen's Service Center, 21 Coenties Slip, New York (directed by United States Public Health Service in co-operation with the American Red Cross).

Sea Power, Washington, D. C.

Shepard Electric Crane & Hoist Company, Montour Falls, New York.—2½-ton electric cargo winch in operation; 1-ton trolley hoist with sections cut away for inspection.

Shipping Publishing Company, 32 Broadway, New York.—*Shipping.*

Shonberg, I., Inc., New York—Samples of Babbitt and bearing metals.

Simmons-Boardman Publishing Company, New York.—MARINE ENGINEERING, SHIPBUILDING CYCLOPEDIA, scientific books on naval architecture, marine engineering and shipbuilding.

Smith Port Publishing Company, New York.—*Port of New York Annual.*

South Atlantic Ports Association.—Photographs of the southern ports and maps of the South.

Sperry Gyroscope Company, Brooklyn, N. Y.—Gyro compass, electric log, 24-inch Navy standard searchlight of 4,000,000 candlepower, and model of midship portion of vessel mounted on trunnions and fitted with model stabilizer.

Sterno Corporation, New York.—Samples of sterno canned heat and also anti-freeze.

Steward Davit & Equipment Corporation, 17 Battery Place, New York.—Twenty-foot metallic lifeboat rigged on Steward davits connected up with Steward falls controller; line-throwing gun rigged for operation; typical oiltight manholes; releasing gear for collapsible and class 1-A boats.

Stone Corporation, Junius H., 1400 Broadway, New York.—"Rubberstone" mineral rubber deck covering.

Sturrock Furnace Bridge Wall Company (Boston Engineering Company, Inc., Boston, Mass.; W. W. Booth, 74 Cortlandt street, New York; Jenkins & Miller, Inc., Seattle, Wash.).—Section of corrugated furnace with bridge wall in place.

Sturtevant Company, B. F., Boston, Mass.—Forced draft turbo blower, battleship type; forced draft engine blower, merchant type; 10-kilowatt kerosene auxiliary generating set; 10-kilowatt engine driven generating set; motor driven ventilating fan; 1,500 cubic foot marine heater, and portable ventilating set with electric lamp socket connection.

Submarine Boat Corporation, 11 Pine street, New York.—120-horsepower Diesel engine built by the New London Ship & Engine Company, Groton, Conn.; relief map of Port Newark terminal of the Transmarine Corporation and Newark Bay shipyard and surrounding territory; model of standard 5,350-ton deadweight vessel built by Newark Bay shipyard; inter-pole motors and generators made by the Electro-Dynamic Company, Bayonne, N. J.; background painting of marine scenery giving names and field covered by each of the subsidiary companies both operating and manufacturing; photographs and aerograph maps as well as slides and moving pictures of the plants and their operation.

Submarine Signal Corporation, New York.—Standard receiving apparatus, submarine bell, power plant for lightship, oscillator, Forbes log, slides showing development of submarine signalling equipment and installations.

Sun Shipbuilding Company, Chester, Pa.—Photographs of the plant and its products; model of 10,600-ton tanker *Atlantic Sun.*

Superior Engineering Company, New York.—Soot blower.

Texas Company, The, 17 Battery Place, New York.—Petroleum "Texaco" products.

Thorne-Pioneer Company, Inc., 3 Atlantic avenue, Brooklyn, N. Y.—Metallic packings.

Thorsen Company, P. S., 81 Coffey street, Brooklyn, N. Y.—Application of 85 percent magnesia covering to steam boilers and steam pipes, and of hair felt to brine lines; samples of various materials used for insulation.

Tiebout, W. & J., New York.—Marine hardware, turnbuckles, thimbles, air ports, rings, I-bolts, bitts, etc.

Todd Shipyards Corporation, 15 Whitehall street, New York.—Exhibition of the Tietjen & Lang plant included a Diesel engine model and turbine with reduction gears; White fuel oil system, burners and atomizers in operation; model of typical Scotch boiler; complete model of the Tacoma plant and of 7,500-ton deadweight cargo vessel built at this plant; the Tebo Yacht Basin plant exhibited a model of the steamship *Ormes* built for the Donald Steamship Company; the Robins dry dock showed a working model of a vessel in process of dry docking.

Topping Bros., New York.—Marine hardware, hand capstan, searchlight, chain hoists, side lights, locks, jacks, paint brushes, axes, etc.

Traffic Service Corporation, Chicago and Washington.—*The Traffic World.*

United Marine Contracting Corporation, 15 Whitehall street, New York.—Automobile truck carrying electric welding apparatus.

United States Mail Steamship Company, New York.—Large decorated wall panel portraying the scope of the company and several easels with pictures mounted giving views of the company's vessels.

United States Metal Packing Company, Philadelphia, Pa.—Models showing their different kinds of metallic packing.

Uttmark's Nautical Academy, New York.—Plotting charts, text books on navigation, ½-kilowatt Marconi wireless set.

Valentine & Company, 456 Fifth avenue, New York.—Valspar varnish; tests of wood covered with varnish under running hot and cold water, etc.

Van Nostrand Company, D., New York.—Scientific and technical books on marine engineering, shipbuilding, naigation, astronomy, fuel, etc.

Victor Engineering Company.—Ash ejector.

Wager Furnace Brick Wall Company, Singer Building, New York.—Model of a furnace bridge wall.

Wailes, Dove, Hermiston Corporation, New York.—Samples of bituminous coatings.

Wall Rope Company, 48 South street, New York.—Large coil of 15-inch manila rope, coil of 15-inch Coir rope, smaller sizes of manila rope and tarred fittings; moving pictures of the manufacture of walk-laid rope.

Ward, Leonard Electric Company, Mount Vernon, New York.—Switches, cross bars and rheostats.

Waterbury Company, The, 63 Park Row, New York.—Booth turned over to European War Relief Council.

Wheeler, C. H., Mfg. Company, Philadelphia, Pa.—Froude dynamometer; turbine driven condensate pump; large size radojet air pump, inter-condenser air pump; single stage radojet; full size model half section radojet air pump.

Whitlock Cordage Company, 46 South street, New York.—Samples of manila fiber and bolt and yacht rope, large coil of 10-inch bolt rope hawser; book on knots and splices with demonstrating board; new rope schedules for Whitlock products; pictures of rope in various processes of manufacture; large paintaing showing hemp fiber in the stripping process in the Philippines.

Williams, William E., 62 Front street, New York.—Brass, steel and iron body valves of globe and cross types; valves with monel metal trimmings for superheated and high pressure steam.

Williams Valve Company, D. T., Cincinnati, Ohio (Williams & Wells, exclusive distributors, New York).—Bronze valves, oil and grease cups.

Wilson Welder & Metals Company, New York.—Two-arc gas driven portable welding unit; two-arc A. C. portable welding unit, one-arc D. C. portable welding unit; track and bond welder; samples of welds and a welding booth for demonstrating the making of welds by the plastic arc system.

Woodward & Chamberlain, Inc., New York.—Harpoons, fish hooks, rigger's tools, marine signals, turnbuckles, thimbles, oars.

Woolsey Paint & Color Company, C. A., Jersey City, N. J.—Samples of marine paint.

Worthington Pump & Machinery Corporation, 115 Broadway, New York.—Steam air ejector; 4-inch centrifugal turbo circulating pump; duplex packed piston pump for feed and general service; turbo feed pump capable of supplying feed water at 390 pounds pressure for 25,000 horsepower; a cabinet of steam pump models; two water color pictures showing a section and elevation of a motorship installation; a Worthington standard surface condenser mounted on a combined air and circulating pump; Worthington-Blake-Knowles type vertical simplex piston pump; Worthington-Blake-Knowles type vertical duplex piston pump for boiler feed and general pressure service up to 300 pounds; piston oil meter, marine type, 300 pounds pressure; the original direct acting steam pump made by Henry R. Worthington in 1840, the first direct acting steam pump ever built.

Young Men's Christian Association, merchant marine section.

Marine Equipment Manufacturers and Shipbuilders Organize

At a meeting held Friday afternoon, January 28, at the Biltmore Hotel, New York, representatives of forty-seven shipbuilding companies, manufacturers of marine equipment and dealers in marine supplies formed an association for the following purposes:

To advance the interests of its members; to promote good will between those who buy and those who sell marine equipment and supplies; to promote and supervise exhibits; to co-operate with other associations in the marine field, to the end that their efforts for the advancement of the designing, building and operation of ships shall be most productive.

An important point brought out at this meeting was the importance of holding the annual marine exposition at the same time as the convention of the Society of Naval Architects and Marine Engineers, the National Marine League, the American Steamship Owners' Association, the Atlantic Coast Shipbuilders' Association, the United States Steamship Operators' Association and others. Shipbuilders are intensely interested in the new inventions and developments in their line of work, and it would be to their mutual advantage if their annual meetings were held at the same time as the marine exposition.

The temporary officers of the association are Colonel E. A. Simmons, Simmons-Boardman Publishing Company, Woolworth Building, New York, acting president; K. L. Ames, Jr., American Steel Foundries, Chicago, Ill., acting secretary.

The following companies were represented at the meeting:

American Car and Foundry Company, New York.
American Engineering Company, Philadelphia, Pa.
American Steel Foundries, Chicago, Ill.
Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md.
Bethlehem Shipbuilding Corporation, Bethlehem, Pa.
Brunswick Refrigerating Company, New Brunswick, N. J.
Coen Company, San Francisco, Cal.
Columbian Bronze Corporation, New York.
Columbian Rope Company, Auburn, N. Y.
Charles Cory & Son, Inc., New York.
Crane Company, Chicago, Ill.
Cutler-Hammer Mfg. Co., Milwaukee, Wis.
Electro-Dynamic Company, Bayonne, N. J.
Estate of Adolph Starke, Brooklyn, N. Y.
Fairbanks, Morse & Company, Chicago, Ill.
Federal Bending Machine Company, Bayonne, N. J.
Gold Car Heating & Lighting Company, New York.
Griscom-Russell Company, New York.
Horne Manufacturing Company, Jersey City, N. J.
Hyde Windlass Company, Bath, Me.
International Nickel Company, New York.
Kelley Industrial Corporation, New York.
Locomotive Superheater Company, New York.
Marine Decking & Supply Company, Philadelphia, Pa.
Marine Engineering, New York.
Marine News, New York.
Naval Company, Philadelphia, Pa.
Niles-Bement-Pond Company, New York.
Page Steel and Wire Company, New York .
Paige & Jones Chemical Company, New York.
Pacific Marine Review, San Francisco, Cal.
Pneumercator Company, New York.
Pyle-National Company, Chicago, Ill.
Shepard Electric Crane and Hoist Company, Montour Falls, N. Y.
Steward Davit Equipment Corporation, New York.
Sperry Gyroscope Company, Brooklyn, N. Y.
W. & J. Tiebout, New York.
The Texas Company, New York.
Todd Shipyards Corporation, New York.
Wailes, Dove, Hermiston Corporation, New York.
Wall Rope Works, New York.
Wheeler, C. H., Mfg. Company, Philadelphia, Pa.
Westinghouse Electric & Mfg. Company, East Pittsburgh, Pa.
Williams & Wells Company, New York.
William E. Williams Valve Company, Brooklyn, N. Y.
C. A. Woolsey Paint & Color Company, Jersey City, N. J.

A committee, consisting of G. W. Selby, Marine Decking & Supply Company, chairman; W. H. Easton, Westinghouse Electric & Manufacturing Company; Gardner Cornett, Pneumercator Company; F. O. Cheston, American Car & Foundry Company; W. M. Wampler, Coen Company; K. W. Heinrich, Bethlehem Shipbuilding Corporation; H. B. Oatley, Locomotive Superheater Company; F. C. Bradbury, Crane Company; J. H. Johnson, Baltimore Dry Docks & Shipbuilding Company; J. R. Tiebout, W. & J. Tiebout, and D. C. Spencer, American Engineering Company, was appointed by the acting president to draft a constitution and by-laws. As soon as the report of this committee is ready, another meeting will be held and a permanent organization effected.

The plans of the Marine Equipment Manufacturers' Association provide that unless for some very special reason not now foreseen there shall be but one show a year to be held simultaneously with the annual conventions of such organizations as the Society of Naval Architects and Marine Engineers.

Progress of Shipbuilding in the United States

TABLE I—STEEL TONNAGE BUILDING AND CONTRACTED FOR IN THE UNITED STATES FOR PRIVATE OWNERS SEPARATED BY METHOD OF PROPULSION

COAST	RECIPROCATING				TURBINE				DIESEL				NO POWER				TOTAL			
	Cargo		Tank		Cargo		Tank		Cargo		Tank		Cargo		Tank		Cargo		Tank	
	No.	G.T.	No.	G.T.	No.	G.T.	No.	G.T.	No.	G.T.	No.	G.T	No.	G.T.	No.	G.T.	No.	G.T.	No.	G.T.
Atlantic	45	115,011	69	486,373	12	61,275	2	12,000	4	16,200	6	57,950	25	9,260	26	14,860	86	201,746	103	571,183
Pacific	..	.....	38	276,307	2	19,000	..	.....	1	3,900	2	3,438	..	.....	..	.....	3	22,900	40	279,745
Gulf	2	7,169	2	15,600	8	48,000	..	.....	1	350	..	.....	3	600	15	5,600	14	56,119	17	21,200
Great Lakes	6	11,916	..	.....	..	.....	..	.....	..	.....	..	.....	..	.....	..	.....	6	11,916	..	.....
Interior	2	400	..	.....	..	.....	..	.....	..	.....	..	.....	109	69,975	..	.....	111	70,375	..	.....
	55	134,496	109	778,280	22	128,275	2	12,000	6	20,450	8	61,388	137	79,835	41	20,460	220	363,056	160	872,128

TABLE II—STEEL TONNAGE BUILDING IN THE UNITED STATES FOR THE UNITED STATES SHIPPING BOARD. SEPARATED BY METHOD OF PROPULSION

COAST	RECIPROCATING				TURBINE				DIESEL				NO POWER				TOTAL			
	Cargo		Tank		Cargo		Tank		Cargo		Tank		Cargo		Tank		Cargo		Tank	
	No.	G.T	No.	G.T.	No.	G.T.	No.	G.T.	No.	G.T.	No.	G.T.	No.	G.T.	No.	G.T.	No.	G.T.	No.	G.T
Atlantic	2	10,880	..	.....	4	23,880	5	34,000	1	10,000	..	.....	..	.....	..	.....	7	44,760	5	34,000
Pacific	12	80,006	3	21,000	4	26,000	..	.....	..	.....	..	.....	..	.....	..	.....	16	106,006	3	21,000
Gulf	3	17,952	..	.....	6	40,800	..	.....	..	.....	..	.....	..	.....	..	.....	9	58,752	..	.....
Great Lakes	1	2,677	..	.....	..	.....	..	.....	..	.....	..	.....	..	.....	..	.....	1	2,677	..	.....
Interior	..	.....	..	.....	..	.....	..	.....	..	.....	..	.....	..	.....	..	.....	..	.....	..	.....
	18	111,515	3	21,000	14	90,680	5	34,000	1	10,000	..	.....	..	.....	..	.....	33	212,195	8	55,000
	Transports		Passenger and Cargo		Transports		Passenger and Cargo										Transport		Passenger and Cargo	
Atlantic	..	.....	4	42,000	4	30,220	16	168,000	..	.....	..	.....	..	.....	..	.....	4	30,220	20	210,000
	..	.....	4	42,000	4	30,220	16	168,000	..	.....	..	.....	..	.....	..	.....	4	30,220	20	210,000

TABLE III—TOTAL STEEL TONNAGE BUILDING AND CONTRACTED FOR IN THE UNITED STATES

COAST	RECIPROCATING				TURBINE				DIESEL				NO POWER				TOTAL			
	Cargo		Tank		Cargo		Tank		Cargo		Tank		Cargo		Tank		Cargo		Tank	
	No.	G.T.	No.	G.T.	No.	G.T.	No.	G.T.	No.	G.T.	No.	G.T.	No.	G.T.	No.	G.T.	No.	G.T.	No.	G.T.
Atlantic	47	125,891	69	486,373	16	85,155	7	46,000	5	26,200	6	57,950	25	9,260	26	14,860	93	246,506	108	605,183
Pacific	12	80,006	41	297,307	6	45,000	..	.....	1	3,900	2	3,438	..	.....	..	.....	19	128,906	43	300,745
Gulf	5	25,121	2	15,600	14	88,800	..	.....	1	350	..	.....	3	600	15	5,600	23	114,871	17	21,200
Great Lakes	7	14,593	..	.....	..	.....	..	.....	..	.....	..	.....	..	.....	..	.....	7	14,593	..	.....
Interior	2	400	..	.....	..	.....	..	.....	..	.....	..	.....	109	69,975	..	.....	111	70,375	..	.....
	73	246,011	112	799,280	36	218,955	7	46,000	7	30,450	8	61,388	138	79,835	41	20,460	253	575,251	168	927,128
	Transports		Passenger and Cargo		Transports		Passenger and Cargo										Transports		Passenger and Cargo	
	No.	G.T.	No.	G.T.	No.	G.T.	No.	G.T.	No.	G.T.	No.	G.T.	No.	G.T.	No.	G.T.	No.	G.T.	No.	G.T.
Atlantic	..	.....	4	42,000	4	30,220	16	168,000	..	.....	..	.....	..	.....	..	.....	4	30,220	20	210,000
Total																	257	605,471	188	1,137,128

Statistics compiled by the Bureau of Navigation of the Department of Commerce show that during 1920 American shipbuilders built for American owners 1,758 merchant vessels of 2,831,343 gross tons as compared with 2,338 vessels of 4,213,891 gross tons during the year 1919. In 1920 twenty-five additional vessels of 29,382 gross tons were built for foreign owners as against 25 vessels of 44,250 gross tons built for foreign owners during the previous year. Of the 1920 output, 617 vessels of 2,557,032 gross tons were built of steel.

According to figures published in the January issue of the BULLETIN of the American Bureau of Shipping, from which Tables I to IV are reproduced, there are now building or contracted for in the United States, 445 steel vessels totaling 1,742,599 gross tons. Of these vessels, 380 of 1,235,184 gross tons are building for private owners and 65 vessels of 507,415 gross tons are building for the United States Shipping Board. Of the vessels building for private account, 365,056 gross tons are cargo ships and 872,128 gross tons are tankers. Of the vessels building for the Shipping Board, 212,195 gross tons are cargo ships; 55,000 gross tons are tankers and 210,000 gross tons are passenger and cargo vessels. The total number of motorships under construction is 15, aggregating 91,838 gross tons, all but one of which are for private account.

TABLE IV—RANGE IN GROSS TONS, OF ALL STEEL TONNAGE BUILDING IN THE UNITED STATES

Size Range	TONNAGE RANGE No.	Gross Tons
under 500	94	32,667
501 to 1000	116	86,041
1001 to 2000	12	17,380
2001 to 3000	8	22,313
3001 to 4000	16	58,213
4001 to 5000	6	27,668
5001 to 6000	38	215,518
6001 to 7000	51	341,063
7001 to 8000	42	312,387
8001 to 9000	23	201,549
9001 to 10000	9	88,600
10001 to 11000	22	231,200
11001 to 12000	..	.....
12001 to 13000	..	.....
13001 to 14000	8	108,000
	445	1,742,599

Of the vessels 1001 Gross Tons and over the average is about 6900 G.

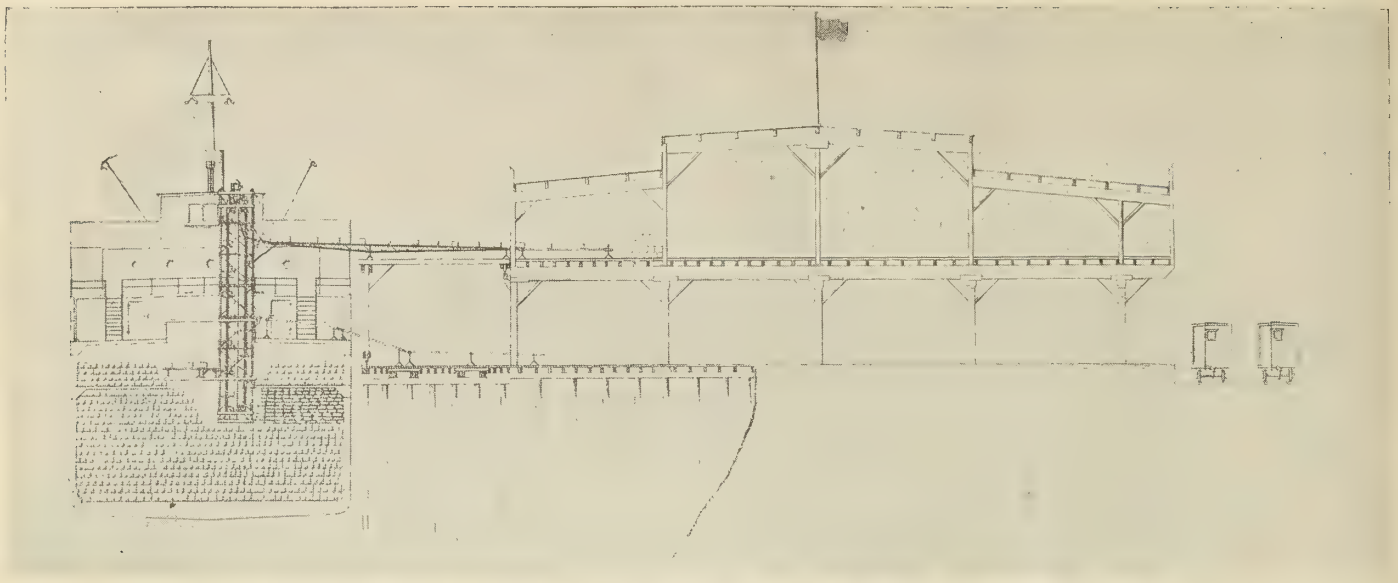
United States Shipyards Built 1,783 Vessels in 1920

During 1920 1,758 merchant vessels of 2,831,343 gross tons were built in American shipyards, according to the report of the Bureau of Navigation of the Department of Commerce. American shipbuilders also built 25 vessels of 29,382 gross tons for foreign owners, making a total output of 1,783 vessels of 2,860,725 gross tons for the twelve months. During the calendar year 1919 the corresponding output was 2,338 vessels of 4,213,891 gross tons for American and 25 vessels of 44,250 gross tons for foreign owners, a total of 2,363 vessels of 4,258,141 gross tons. Of the 1920 output, 617 vessels of 2,557,032 gross tons were built of steel, a decrease of 299 vessels and 1,012,792 gross tons compared with 1919.

The following details of vessels built and officially numbered in the United States in 1920 are reported by the Bureau of Navigation, Department of Commerce:

	Atlantic & Gulf		Pacific		Great Lakes		Western Rivers		Total	
Wood	No.	Tons	No.	Tons	No.	Tons	No.	Tons	No.	Tons
Sailing	72	73,629	18	37,067	1	2,051	..	....	91	112,747
Steam	52	12,122	20	39,011	20	1,963	11	1,039	103	54,135
Gas	313	12,049	280	19,003	50	1,019	62	1,024	705	33,095
Unrigged	164	65,816	35	5,626	18	2,274	25	618	242	74,334
Total	601	163,616	353	109,707	89	7,307	98	2,681	1,141	274,311
Metal—										
Sailing	1	1,189	..	....	..	....	..	....	1	1,189
Steam	*337	1,627,744	†120	700,039	67	169,811	4	3,802	528	2,501,396
Gas	14	21,200	6	3,963	1	55	8	156	29	25,274
Unrigged	39	20,459	1	165	‡9	3,271	10	5,278	59	29,173
Total	391	1,670,592	127	704,067	77	173,137	22	9,236	617	2,557,032
Totals—										
Sailing	73	74,818	18	37,067	1	2,051	..	....	92	113,936
Steam	389	1,639,866	140	739,050	87	171,774	15	4,841	631	2,555,531
Gas	327	33,249	286	22,866	51	1,074	70	1,180	734	58,369
Unrigged	203	86,275	36	5,791	27	5,545	35	5,896	301	103,507
Grand total	992	1,834,208	480	804,774	166	180,444	120	11,917	1,758	2,831,343

* Includes 4 vessels of 25,940 gross tons built of reinforced concrete.
† Includes 3 vessels of 19,116 gross tons built of reinforced concrete.
‡ Includes 4 vessels of 1,224 gross tons built of reinforced concrete.



View Showing Elevator Loading at Second Deck, High Tide, Ship With Practically Full Load

Automatic Cargo Handling Proposed

DUE to the wide variety of cargo weights and sizes handled on its piers, the Port of Seattle Commission has constantly sought to facilitate the handling problem.

As a result of this effort a new and practical cargo handling equipment has been designed by George F. Nicholson, chief engineer of the Port of Seattle. This device is largely automatic, power-driven and is especially designed for handling cargoes brought to Seattle in great volume by the United States Shipping Board's fleet of 8,800-ton vessels engaged in the Orient, South American, Atlantic seaboard and European trade. The device is in the shape of an elevator, is placed in a perpendicular position in the hold of a vessel berthed at the pier, and can handle approximately 4,500 pounds of package cargo every minute.

The device is designed as a ship's cargo elevator, and it will be constructed particularly for the new Smith Cove Pier B terminal, a description of which appeared recently in the columns of Marine Engineering. This terminal, the largest in the world, is prepared to handle a big volume of package cargo, and in this handling the new ship's elevator is expected to be a speedy and labor-saving agency.

While designed for Pier B, the ship's cargo elevator may be used in a ship at any pier having a wide apron. It is of steel frame, 43 feet long, the frame being portable in order to allow it to be set aside on the pier when not in use. It has a total weight of 8,000 pounds and may be picked up in two parts, each part weighing 4,000 pounds, by the ship's boom and spotted in the hold of the vessel. When both parts have been spotted in the hold the frame is simply bolted together, the frame standing upright in the hold. This structure, having been installed in the ship's hold, is braced with guy wires from the coning beam to the ship's side. An endless chain revolves in this frame and fastened to this chain are fingered trays five feet apart, each tray having a capacity of 300 pounds.

The cargo is brought to a receiving table by means of gravity rolls. Package cargo is then taken from the receiving table and sent down an incline chute to a stationary receiving tray. The equipment is adjusted so that the fingers of the moving trays pass between the fingers of the stationary tray, thereby catching the cargo on the latter tray and moving it up the frame to the top, where the cargo is discharged by a similar tray automatic trip. Gravity rolls on power conveyors catch the released cargo and the freight is thus taken inside the pier. This power conveyor is set at the same speed as the elevator.

Another feature of this cargo elevator is that it can be operated at the same time the ship's winch is being operated on the heavier freight, thus saving handling and facilitating the unloading of the vessel. The elevator will operate at the rate of 60 feet a minute. It is motor driven, the motor being located at the top and connected by a belt to the driving wheel.

This machine, says Chief Engineer Nicholson, will be of material assistance in handling such package cargo as salmon, pineapples, sugar, flour and similar freight.

Merchant Marine Association Holds Convention

(*Continued from page* 160)

Shipping Board should promise to allocate no steamers for operation in that service.

W. A. Harriman

W. A. Harriman, chairman of the Board of the United American Lines, stated that we were receiving very little benefit from the Merchant Marine Act and that exemption from excess profit taxes would not be much of a factor in the future. He declared that we could not stay a great export nation without the proper development of our merchant marine.

Mr. Harriman quoted some very low figures at which foreign merchant and passenger vessels are being offered and, while doubting the ability of the Shipping Board to dispose of its vessels at any price at the present time, he suggested that the Shipping Board should fix a price on their vessels that would allow the shipowner to compete with foreign owners.

Frank C. Munson

Frank C. Munson, president of the Munson steamship lines, stated that we now have 25,000,000 deadweight tons of shipping under our flag, fifteen million tons of which are in foreign trade, which is ten times as much as we had ten years ago. He said that the Shipping Board exerted a vital influence on shipping, that shipowners were afraid to buy ships now because they did not know what the policy of the Board would be. In regard to fixing prices, he recommended that the Board ascertain what the book values of foreign ships are.

Mr. Munson believes that it would pay the Board to remove the boilers and engines of some of the vessels and install Diesel engines. He favors the bare boat system of chartering because it would force operators to carry on business for

profit or loss. Two dollars to $2.75 per deadweight ton should, in his opinion, be a fair price for the ships and should include both manning and victualing.

Mr. Munson declared that 50 percent of the tonnage now tied up by the Shipping Board could be run if it took competing rates, and that a number of foreign ships were now being used by foreign operators. He believes in co-operation with Great Britain and other nations in the development of the world's trade.

Resolutions Adopted by the National Merchant Marine Association

RESOLVED, By the National Merchant Marine Association that, in order to establish the full practical value of the measure in the development of the new merchant shipping of the United States, we strongly urge the immediate and faithful enforcement of the Merchant Marine Act of 1920.

RESOLVED, That the personnel of the United States Shipping Board be put upon a basis of permanency, in order that a constructive administrative policy may be carried out in the application of the law.

RESOLVED, That private American enterprise must be encouraged to engage in shipping through the means of national aid wherever found necessary by the Shipping Board, to the end that American ships under the American flag may operate in competition with foreign ships in the same trades.

RESOLVED, That in order that the farmers, manufacturers and other producers of this country shall be enabled to compete successfully in foreign markets, and in order that ultimately our merchant marine shall be privately owned by citizens of all sections, we urge that it should be decided what new mail, passenger and cargo routes are to be established and operated by the Shipping Board from our various ports and that arrangements should be made, accordingly for their present and future development, with a view to the purchase of routes and ships as soon as practicable by companies and individuals, selected wherever possible from their respective sections or ports.

RESOLVED, That wherever reasonably adequate services are already being performed by private owned ships or by Government owned ships in the hands of private operators, the Shipping Board be urged to cease to allocate further tonnage to these particular routes, so that the concerns already in these trades may have a fair chance of development.

RESOLVED, That it is evident that the high prices at which Shipping Board vessels have been sold to purchasers are proving an excessive burden on American operating companies in competition with the ships of foreign nations, and that we, therefore, urge that an equitable plan of relief be devised and applied in these cases by the Shipping Board.

RESOLVED, That we heartily approve the present policy of enrolling in the naval reserve competent American officers and men of the merchant marine, and that we recommend that this policy be broadened and made permanent by the Navy Department and by Congress.

RESOLVED, That in the interest of the navy and the merchant marine alike in which so many young men of the Middle West are serving, we urge that the important naval training station on the Great Lakes be not abandoned by the Government.

We deplore pessimism and destructive criticism and we respectfully urge upon Congress and upon the people of the United States a spirit of constructive co-operation, a spirit of optimism, and a firm determination to achieve, in spite of all difficultes, our national purpose of developing and maintaining an American merchant marine for the National defense and for the proper growth of our foreign and domestic commerce.

Passenger Steamer Modasa Launched

THE *Modasa,* a fine twin screw screw passenger steamer of the intermediate type for the British India Steam Navigation Company, Limited, was recently launched from the Neptune yard of the Swan Hunter and Wigham Richardson Company Limited, Newcastle-on-Tyne. The vessel is about 480 feet in length by 58 feet breadth by 36 feet depth. She is being constructed to attain the highest class in Lloyd's Register and the watertight subdivision and arrangements are in accordance with the International Convention requirements.

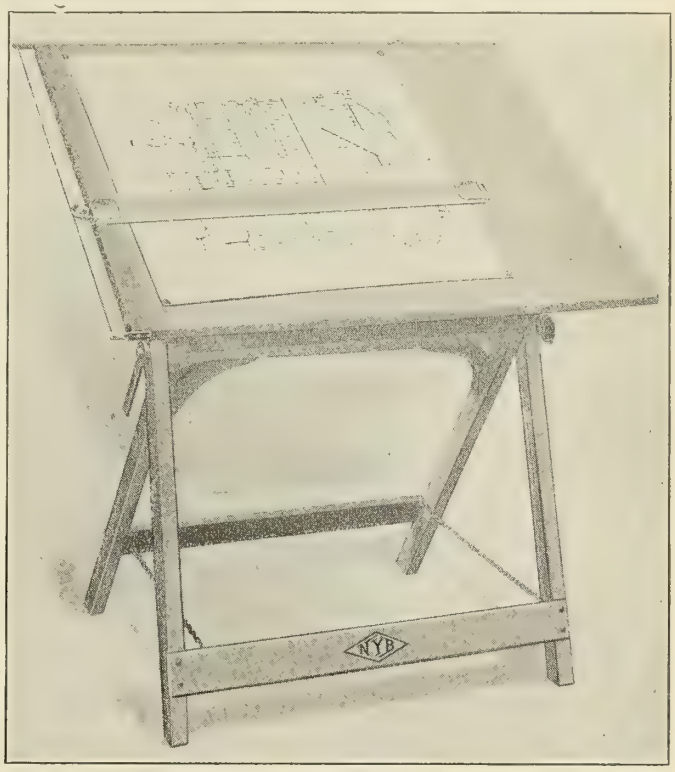
The steamer is expected to carry about 10,750 tons deadweight and will be fitted with accommodation for about 80 first class, 40 second class and 36 extra berths which can be used either for first or second class passengers. Large dining, smoking and music rooms are provided for both classes of passengers, all these public rooms being on the promenade deck, and a special feature of this deck is the large extent of clear deck space for games and recreation.

The main propelling machinery consists of a twin set of double reduction geared turbines of the Metropolitan-Vickers Rateau type, supplied with steam by five large boilers constructed also by Swan, Hunter & Wigham Richardson, Ltd., at their Neptune Works. A sea speed of about 14 knots is anticipated.

The vessel will be well supplied with auxiliary machinery for purposes of navigation and for working the cargo, including 15 steam winches, steam steering gear, etc. The vessel will be lighted electrically, steam heating will be fitted throughout and there is refrigerating machinery for insulated chambers for ship's provisions. There will be an installation of wireless telegraphy, together with an ample supply of boats, etc.

Parallel Ruling Attachment for Drawing Boards

THE New York Blue Print Paper Company, 102 Reade Street, New York, manufacturers of drawing and tracing papers and drafting room equipment, has developed a parallel ruling attachment which may be applied to any drawing board, large or small, with the complete elimination of cords or wires on the surface of the board. Similar cords are also done away with on the under side of the board together with the metal parts which have been necessary to give the straight edge the required accuracy in producing parallel lines.



Precise Parallel Ruling Attachment

The Precise parallel attachment consists of a double pulley plate, a plate with two small pulleys which are fastened at either end of the straight edge and four metal brackets to which the cords are attached and a small grip to hold the cords firmly. The combined weight of the attachment parts is about two ounces.

Correction.—Inadvertently the Jacksonville Ship Outfitting Yard, Jacksonville, Fla., was omitted from the list of repair yards published in the January, 1921, issue of Marine Engineering. This yard has no dry dock but is equipped with a fabricating shop, boiler shop, smith shop, pipe shop, carpenter shop, joiner shop, tin shop, coppersmith shop, plumbing shop, rigging shop and sail loft, electric shop and machine shop and is engaged in general repair work. The yard has 700 feet of waterfront and there is a 50-ton traveling crane with a 125-foot boom to facilitate work such as the removal of machinery.

In the same article it was erroneously stated that the Lord Dry Dock Corporation has a 10,000-ton marine railway at its Weehawken, New Jersey, plant. This plant will be equipped with dry docks of from 1,000 to 10,000 tons lifting capacity, but will have no marine railway.

Marine Engineering

Published Monthly by

ALDRICH PUBLISHING COMPANY

In Conjunction With

SIMMONS-BOARDMAN PUBLISHING COMPANY

6 East 39th Street and Woolworth Building, New York

F. B. WEBSTER, Editor
H. H. BROWN, Managing Editor

S. M. PHILLIPS, Associate Editor
A. J. KAUFMANN, Associate Editor
L. S. BLODGETT, Associate Editor
W. Z. GARDNER, News Editor

Contributing Editors

Rear Admiral C. W. Dyson, U. S. N.
Commander S. M. Robinson, U. S. N.
Professor C. H. Peabody
Captain C. A. McAllister, U.S.C.G. (Retired)
William Gatewood
H. McL. Harding
William T. Donnelly
James L. Bates

MARINE ENGINEERING is copyrighted and registered in the United States Patent Office. Copyrighted in Great Britain.

WE GUARANTEE that of this issue 8,200 copies were printed; that of these 8,200 copies 6,576 were mailed to regular paid subscribers, 360 were provided for counter and news company sales, 325 were mailed to advertisers, 79 were mailed to employees and correspondents, and 860 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 17,700, an average of 8,850 copies a month.

MARINE ENGINEERING is a member of the Associated Business Papers, Inc. (A. B. P.), National Association of Periodical Publishers, Inc., New York Business Publishers Association and the Audit Bureau of Circulations (A. B. C.).

Subsidy Versus Government Ownership

IT is immaterial whether the direct cost of our merchant marine is three or four billion dollars. The indirect cost is practically the whole national debt and the loss and maiming of hundreds of thousands of our young men. Germany would never have gone to war with us if we had had a large merchant marine; in fact, if we had as many ships in 1914 as we have now, there probably would not have been any war. We can never again allow our Navy to depend on the merchant vessels of a foreign nation, and if our laws are not such that private owners can operate these ships successfully, the Government must operate them itself.

The consensus of the best opinion in the shipping world is that the merchant marine can be developed for the best interests of the country in the hands of private owners, but if this is to be done we must fix it so that our operators can meet foreign competition on an equal basis. An excellent start has been made with the Merchant Marine Law of 1920. Section 23 provides that the owners of a vessel documented under the laws of the United States and operated in foreign trade shall be exempted from the excess profit taxes provided that this money is invested in new vessels. As the Shipping Board has already approved the applications for about $60,000,000 worth of new construction under the provisions of this section, it is evident that this form of subsidy is proving a success for both the shipping and shipbuilding industries. The construction loan fund (Section 11), which provides that a sum of $25,000,000 may be annually set aside to be used to aid in the construction of the best type of vessels, is not a subsidy, but it is excellent constructive legislation.

Section 28, which provides that preferential rail export rates may be granted only to American vessels, is an indirect subsidy. This section has not yet been put into operation, the excuse being that sufficient American vessels were still unavailable to carry our commerce. In view of the number of government vessels recently tied up, it is hard to see the logic of this explanation, and it would seem that as we have a reserve of ships to draw from that now is the time to try out the provisions of this section.

Another form of indirect subsidy is contained in Section 34, which provides that treaties with foreign powers which prevent the right of the United States to impose discriminatory customs duties on imports entering the United States in foreign vessels and discriminatory tonnage duties on foreign vessels, should be terminated. The present administration has taken no steps to comply with this law in spite of the fact that this is a most critical time in the development of our merchant marine. Our first Congress lost no time in enacting similar discriminatory duties, with the result that our merchant marine was built up to such a degree that we carried 80 percent of our commerce in our own ships. The new administration is confronted with the difficult problem of deciding whether the above-mentioned discriminatory duties or an equivalent direct subsidy will best serve our interests. Among the objections to the impositions of discriminatory duties may be cited the length of time necessary to revise existing treaties, the effect on our foreign relations and the retaliatory legislation that may be enacted by foreign powers. On the other hand, it has been very difficult in the past to interest Congress in direct subsidies, and if direct subsidies cannot be obtained, then the provisions of our treaties that prevent the imposition of discriminatory duties should be abrogated and the law enforced.

Passenger Vessels

"NEW passenger vessels must be built and there is a tremendous construction programme in mind for coastwise services," said Mr. Homer L. Ferguson, president of the Newport News Shipbuilding & Dry Dock Company, in his opening address at the recent meeting of the Society of Naval Architects and Marine Engineers. Almost the entire efforts of the shipbuilding industry during the war were devoted to the construction of ocean-going cargo vessels, with the result that we will be temporarily overstocked with freighters until the world resumes its normal trade. On the other hand, the submarines and natural causes have reduced the number of passenger vessels to such an extent that there is an indefinite prospect of work ahead on this type of ships.

That England is not unaware of the possibilities of liner construction is evident from a paper recently read before one of their technical societies and referred to in a speech at the launching of the Canadian Pacific steamship *Montrose* at the Fairfield yard on the Clyde. It was stated that in 1914 there were 3,100 vessels of the liner type having a total tonnage of 13,350,000 tons and that today there are only 2,470 such vessels, which is 630 less than there were in the prewar days. Sooner or later this tonnage, with the natural increase, which represents a shortage of about 2,000,000 tons, must be made up, and it is only the high cost of construction and labor conditions in England that is holding this work back.

It is known that many American steamship lines are planning the construction of new vessels, taking advantage of Section 23 of the Merchant Marine Act of 1920, which provides that excess profits earned by American ships are exempt from taxation provided they are invested in the construction of new

ships. If our well-equipped shipyards receive the proper co-operation from their employees in regard to this proposed work, there is no question of our ability to produce the best type of ocean liners. We refer those who doubt this to the Nestor of all vessels—the American battleship.

Marine Expositions

MARINE Expositions present a splendid opportunity to the naval architects, marine engineers and all of those connected with the shipping and shipbuilding industry to examine and study the latest developments in equipment, supplies, ships, dry docks, etc. For this reason it is very important that the date at which a marine exposition is held should coincide with as many of the anual meetings of the marine associations and societies as possible.

The very fact that the attendance of a large number of the ship and engine designers who supervise the plans and specifications of everything that goes into a ship could be assured, would influence both the quantity and quality of the exhibits. There is no good reason why the exhibitors, who after all make an exposition possible, should not receive the maximum benefit for the expense and time that they spend on their display.

The expense of these exhibitions is not a small matter, the cost of floor space at the Grand Central Palace, for example, being more than six times the amount paid by the railway people for their annual exhibition at Atlantic City. Can we not have closer co-operation in the future between the various associations in the marine field with a view to not only reducing the cost but also of promoting a closer bond between the buyer and seller of marine equipment?

The Shipping Board

IT is reported that President-elect Harding will name a new Shipping Board immediately after taking office and that the Senate will be called in extra session right after the inaugural ceremonies to confirm his nominations for Cabinet officers and the Shipping Board. The incoming administration and the Republican leaders in Congress have given every indication that they consider the welfare of our merchant marine of the utmost importance, and it is believed that President-elect Harding will give a great deal of his personal attention to our shipping policies.

It is hoped that the above report is true and that the new administration will consider it one of its first and most important duties to appoint a board composed, for the most part, of practical marine men who have established their fitness for the work and who have the confidence and respect of the shipping and shipbuilding industries. It is not easy to find able men who are available for this work and who are willing to make personal sacrifices in order to help build up a great American merchant marine, but now that the election is over and the whole-hearted support of the administration is assured it should be much easier than heretofore to obtain a capable and efficient Shipping Board.

Too much credit cannot be given to Admiral W. S. Benson and Mr. J. A. Donald for their splendid service on the present board, as they have kept courageously and fearlessly at their stupendous task in spite of the investigation and acrimonious criticism that has been almost continually directed at the Shipping Board. Let us hope that the new board will be made up of men of their character, ability and knowledge of the shipping game.

Again the Metric System

REPRESENTATIVE FRED A. BRITTEN, of Illinois, backed by the World Trade Club of San Francisco, introduces a bill for the general use of the metric system after ten years in commercial transactions. The manufacturer is to be allowed to use any weight or measure in production. Representative Britten states that only the lack of consolidation of interests advocating complete adoption of the metric system accounts for previous failures; now the metric forces make an impressive front. There may be an impressive front, but this is a flank attack appropriatively camouflaged, and with delayed action. If it were certain that such an act would clear the field for ten years it would be good politics to let the act through; the manufacturer would continue to manufacture and the traders to trade, and the good old English system would enormously strengthen its hold on industry. The opinion has been expressed in this magazine that the English system cannot be dislodged; ten years will not make that easier.

Labor-Saving Tools in England

THE trades unions in England are doing all they can to stop the use of labor-saving devices. As a result of this mistaken policy on the part of labor a great deal of work that would ordinarily have gone to British shipyards has been diverted to the Continent. For example, an oil tanker which recently struck the rocks in the Channel, damaging her bottom very seriously, was placed in an English dock for repairs. A contract was made to put a new bottom on the ship for £60,000, but the workmen refused to use labor-saving tools and appliances on the work and the repair yard was compelled to approach the owners and point out that, owing to the unexpected refusal of the men to use labor-saving tools, it would be necessary to increase the price by about £7,000. The owners refused to accept the additional cost and the bottom was therefore patched up and the ship taken to Rotterdam.

Information has been received from one firm that the workmen have recently decided not to use labor-saving tools in their shipyard. The firm insisted on their use, but the men stated that they would take every opportunity to damage them, and the result became so serious that tools were returned to the shop badly damaged after being in use for only an hour. In some cases the damages have cost over £5 to repair, and as it is quite obvious that no firm can continue to use tools that require £5 an hour for maintenance, all portable tools have been withdrawn from service in this particular yard. In some yards on the south coast and the English Channel all pneumatic tools have been put out of service by the men. The executive of the boiler maker's union in Cardiff recently stated that no more labor-saving tools were to be used by members of the unions for the time being.

The United States owes a great deal to labor-saving devices and machines for its rapid development. Such tools in-

crease production, and it is largely through their use that the present standard of living has been obtained. Sooner or later the use of labor-saving tools makes it possible to employ more men because they open up projects that could not otherwise be undertaken. The amount of work to be done will surely keep increasing until the multitudes of Asia and Africa have raised their standard of living to somewhere near our own, and the workmen who object to the most expeditious methods of production are not only delaying progress, but they are also injuring themselves and their country.

The Standards

In a certain vault at the Bureau of Standards there are three platinum kilograms, one in the middle standing a little higher than the others. There are three platinum meters, two in sight and the other sealed in a lacquered tube where it has been ever since Roosevelt put it there. The two side kilograms are for use on occasion, the middle one can be seen but is never touched; in like manner there are two meters for use, the absolute standard cannot even be seen.

In an adjoining room are the balances for comparing standard weights. Each balance is in its own glass case and there are mechanisms for shifting weights without opening the cases. The observer stands off and views the balance through a telescope. When weighings are made the door to this room is shut so that stray drafts of cold air shall not trouble. A 50-pound weight is a sizable chunk of brass, and a thousandth of a milligram is a fleck that can be seen only in a good light; that gives the degree of precision.

On these standards depends the interchangeability which is the basis of the American industrial system. Few people know where the vault is and fewer have entered therein. There is but one key to the inner door, and when the Director of the Bureau wants to go in he sends for the man who carries that key.

The Sinews of War

It used to be said that money was the sinews of war and a prudent government kept a war chest or the equivalent. We have recently learned that there are times when money will not always buy the munitions of war. The term munitions can be enlarged to mean all the requisites, for example freighters; the history of Hog Island and the wonders accomplished there show that money alone is insufficient, though expended lavishly.

Narrowing our field, let us notice the discussion in the Senate of the two materials, oil and nitrogen. Speakers have called attention to the scramble for oil by the European nations, all of them debtors to the United States and supplicating further extension of credit. There is little disposition to blame those nations, but the plight of the United States is pointed out; we are handicapped in the competition for foreign oil, while our own supply is insufficient and there is no way of protecting it.

It is notorious that the Mussels Shoals nitrogen plant cost $87,000,000—lavishly expended because money will not buy time. Now $12,500,000 are asked to complete the construction of the plant. Fortunately, the plant can be used in peace to make fertilizers and perhaps may pay running expenses; maybe government bookkeepers can show a profit some time. But that is not the question; we should have a sufficient means of making the nitrates needed for modern warfare.

It used to be said that it took a ton of iron to kill a man; the modern rate has not been given out, nor the weight of the powder to drive it.

The Present Status of Naval Engineers

Though there is no corps of engineers in the navy there are naval engineers, or shall it be said that there are officers in command of the engine room? And yet there is not complete satisfaction with the present condition as evidenced by the following quotations from a discussion in the *Journal of the Naval Institute*: "The average engineer enjoys the title of his office because he has been so detailed.....he realizes that he must not be too closely identified with engineering duty for too great a length of time," etc. This must not be taken as representing general opinion in the navy and it is unfair to draw conclusions from fragmentary quotations, but there remains the question whether the present status of naval engineers is satisfactory. It should be remembered that the amalgamation of the staff and the line came about because of friction between the branches of the service and there are those who question the wisdom of that move. Now is a good time to take account of stock and see whether present conditions are satisfactory and whether changes should be made.

The Air Service

There is a disposition to unite the air service of the army and navy and form a new department co-ordinate with the war and navy departments, thus avoiding duplication of efforts. Such action should be taken only after mature deliberation, if at all. There are various reasons why the navy desires to keep control of its own service; some of these are administrative and some are due to the nature of the service over the sea.

Though there have been trials of methods for launching an airplane from a ship and for return to the deck of a specially constructed ship, seaplanes normally rise from the water and return to the water and are provided with pontoons for those purposes. The construction of seaplanes is different from the army planes and they are maneuvered in a different manner; a pilot may learn to fly various types of planes, but the best results are had by limiting a man to one class. All persons serving at sea must get the sea habit; not all persons can get the habit; if a flyer is so far affected that he feels uneasy and not quite fit, he is in no condition for his exacting duties.

Perhaps the administrative reasons are the most inexorable. The history of warfare is strewn with failures of combined expeditions of the army and navy. Leaving aside failures due to jealousy and to uncertainty of responsibility, there remain the difficulties of proper co-ordination and understanding; the two services do not speak the same language, although, unfortunately, they think they do.

Our navy has always carried marines, soldiers and sailors too. They always will form an arm of the navy and the seaplanes and dirigibles working with the navy should always belong to the navy and be imbued with the naval spirit.

LETTERS TO THE EDITOR

Diesel Electric Drive for Low Powered Cargo Vessels

In the December, 1920, issue of Marine Engineering there is an article by Commander S. M. Robinson, U. S. N., entitled "Diesel Electric Drive for Double Ended Ferry Boats and Low Powered Cargo Vessels." In the case of low powered cargo vessels of about 10 knots requiring about 1,500 shaft horsepower the author draws the conclusions that the use of Diesel electric propulsion instead of direct connected Diesel propulsion shows up remarkably well.

I venture to dispute Commander Robinson's argument, particularly as he has based his comparison on an assumption that twin screws would be required for a direct connected installation, and that a single screw can be used for the Diesel electric drive. If this assumption is made on the grounds of reliability it would hardly seem justified, since there are Diesel engines with such consistently good records of performance that a single screw, six cylinder installation of the power required for this vessel should be considered well within the bounds of good practice. Such an installation should certainly be considered as reliable as a single electric motor.

If it is a question of propeller efficiency, there are no Diesel engines except the opposed piston type that can be considered for speeds much below 110 revolutions per minute, but it is also true that an electric motor for a speed as low as 81 revolutions per minute would be unduly large and heavy, and correspondingly costly. The propeller of greatest efficiency, as Commander Robinson has demonstrated, will be one operating at 81 revolutions per minute, but the difference in efficiency between that and one operating at 110 revolutions per minute should not justify going to twin screws and losing thereby 13.2 percent in propulsive efficiency, as Commander Robinson has also demonstrated

Using the hull data given, the tabulation in Table I will indicate the essential differences between the propeller given by Commander Robinson and a propeller which will fulfill the conditions demanded by direct Diesel drive.

These are both three-bladed wheels, but the comparison holds for four-bladed wheels which are more desirable for vessels of this type. It is not the intention of the writer to put forward the claim that propeller No. 2 is as good a wheel as propeller No. 1, but it is almost always necessary to compromise between the most desirable wheel and the size and weight and revolutions of machinery installed to drive it.

The difference in propulsive coefficient in the two screws given above is .8 percent. The electric conversion losses as given by Commander Robinson will not be less than 13 percent. Consequently when the two systems of propulsion are compared on the same basis, i. e., with single screw for each, the difference in efficiency is approximately 12 percent in favor of the direct connected engines.

The writer had occasion recently to investigate this problem for a proposed vessel of 6,500 tons deadweight. For electric drive the cost of propelling machinery only, with exciters and controllers, comes to $185 per shaft horsepower and the weights 472 pounds per shaft horsepower. For direct connected Diesel engine of the same type and make as those figured on for the electric proposition, and including two auxiliary generators direct connected to Diesel engines for operating the auxiliary machinery, the cost amounts to $156.40 per shaft horsepower and the weights 413 pounds per shaft horsepower. There is, therefore, in this instance a saving in favor of direct connected engine of $28.60 per shaft horsepower in the cost of the machinery installation and of 59 pounds per shaft horsepower in the weights. The electrically driven ship would require 13 percent to 15 percent more engine power than the other, with a proportionately greater fuel consumption. The auxiliary machinery is not included in the above, as it is practically the same for both cases. The direct connected Diesel drive was figured for 105 revolutions per minute and the electric motor drive for 125 revolutions per minute. The revolutions for electric drive were not brought down on account of the extremely large size of the motor.

There is no question that the electric drive is the more flexible of the two and has superior maneuvering qualities, but for ordinary slow speed cargo vessels the modern Diesel engine possesses these qualities to a sufficient degree.

Wm. Mulheron, Assistant Chief Engineer.
Chester, Pa. Merchant Shipbuilding Corporation.

TABLE I.

	Propeller No. 1	Propeller No. 2
	Single Screw as Designed by Commander Robinson for Electric Drive	Single Screw Suggested for Direct Diesel Drive
$L.W.L.$	324	324
B	47	47
H	21	21
$\frac{B}{L.W.L.}$	.145	.145
$N.B.C.$	.76	.76
K	1.23	1.23
$S.B.C.$	.817	.817
$\frac{2L.A.B.}{H}$	10.3	10.3
S	.21	.21
v	10	10
$e.h.p.$	910	910
$\frac{e.h.p.}{E.H.P.}$	.305	.4
$\frac{v}{V}$	.729	.84
$\frac{et}{E.T.}$	.415	.475
V	13.71	11.9
$E.H.P.$	2,980	2,275
D	16	14.25
$\frac{P.A.}{D.A.}$	.25	.265
$T.S.$	6,000	6,230
$P.C.$	.703	.695
$I.T._D$	2.75	3.1
$I.H.P._d$	1,517	1,550
P	14.75	10.75
s	.1506	.142
R_a	81	110

French Tankers.—The Review of the American Chamber of Commerce in France, states that the number of French tank vessels now in service is 9, aggregating 51,270 tons deadweight. Twenty-eight more aggregating 27,250 tons, are being built.

NEW BOOKS

Design of Warships

REVIEWED BY C. H. PEABODY, DR. ENG.

General Design of Warships. By William Hovgaard, professor of naval design and construction, Massachusetts Institute of Technology. Size, 7½ by 10 inches. Pages, 310. Illustrations, 64. Tables, 18. Plates, 10. New York and London, 1920: E. & I. N. Spon, London, and Spon & Chamberlain, New York.

This work completes a series of three text-books by the author covering the part of the curriculum which is given by him at the Massachusetts Institute of Technology to officers designated for the corps of naval constructors, and representing nearly twenty years spent by the author in developing his subject. The other two books are *Modern History of Warships,* recently reviewed in this magazine, and *Structural Design of Warships,* which was published five years ago, but which logically is the work which completes the series. Taken together, these text-books are a notable contribution to the literature of naval architecture, especially as applied to the military side of the profession.

After a preliminary discussion of the principles, limitations and compromise of warship design, the author discusses the limitations of size of warships, with the conclusion that there is as yet no other limitation than expense and typographical conditions such as harbors and docks; the latter may almost be included in the former, since with the expenditure of time and money such restrictions may be modified, if not removed. The conclusion that may be drawn from this discussion and from the author's other works is that the control of the sea depends on capital ships which must be of large, if not of the largest, size; this is a matter of vital interest to our country at this time.

The preliminary determination of the displacement of a ship is made by two methods: (1) by percentage, (2) by the development of a weight equation. The first assumes that the weight of a new ship will have the same distribution as a ship or ships already built and for which the weights are known. Knowing the weight of the armament of a new ship and all the percentages a single proportion gives all the weights. If the new ship differs essentially, that difference is applied to the old ship, its percentages are corrected and then are used as before. This method calls for extensive computation and tabulation extending over a series of years, but it can be applied with celerity and a fair degree of certainty. The second method was first proposed by Normand in 1901, but is here presented in a modified form. A general equation of weights is developed with variables each having its proper exponents. The equation is then differentiated and is used as an equation of finite differences by which increments of displacement of 25 percent can be dealt with, avoiding errors of more than 2 percent. Having the displacement, the principal dimensions, length, beam, draft and freeboard can be assigned by comparison with the type ship or ships on which the design is based.

With the preliminary design in hand the naval architect is in condition to make a detailed study of his problem and to consider the influence of each of the main dimensions and the effect of modifications of them. Thus the length obtained by the preliminary solution is liable to be inconvenient for various reasons; in fact, it may be said that the next step is to consider whether the length cannot be reduced without unduly compromising the design. The designer must make a careful study of the influence of length on speed, and particularly the interrelation of the speed and length of his special problem to avoid critical conditions due to wave formations and their interferences. Sometimes a minor change in the proportions of the ship will lead to a good solution of the problem. All such changes must be made with a view to the effect of changes of beam and draft on power and speed. We have spoken of the main dimensions as though they directly determined the relation of power and speed; in part they do, but the indirect influence through the determination of the shape of the hull may be even more important. The influence of shape is subtle, varying with both absolute size and speed and with the relation of speed and size. This problem is best studied in the light of model experiments and may call for special tests of relative models for the problem in hand.

Of equal importance is the determination of the probable stability of the ship under design and of the relation of the natural periods of rolling and pitching to the periods of the waves which the ship is likely to meet, both their natural periods and the relative periods as affected by the course and speed of the ship. The choice of metacentric height is complicated by the fact that the ship should have proper stability both when intact and when subject to injuries from gun fire, torpedoes and mines, without being so stiff that it cannot provide a steady platform for the ordinance. The author finds that a simplified theoretical discussion of stability can be made to yield results that will almost always guarantee a proper condition and range of stability for the design. In general, the designer can have a fair control of transverse stability, even if he must accept a compromise; but longitudinal stability and its effect on pitching cannot be so well controlled and the designer can at best only avoid undesirable extremes. Ships may be divided into two classes—those that are 500 feet long or more, such as battleships and large cruisers, and those that are shorter, such as small cruisers and destroyers. Large ships are longer than the waves that they are likely to meet, and when they meet very long waves these have only small relative heights; such ships seldom pitch badly. Small ships are liable to pitch excessively under some conditions.

Having the dimensions and proportions of the ship determined, the designer proceeds to lay down the lines and make an original determination of the displacement and other properties, including strength. The author explains and recommends Admiral D. W. Taylor's mathematical method of drawing lines, a method devised in the first place for laying out groups of models for the experimental basin, and which ensured that models should form a true series and all be fair.

The weight schedule is now to be revised and computed in detail both to ensure the success of the design and to furnish a basis for future designs. Along with this there is made the proper trim diagrams and the computations for strength. For this work the integraph is invaluable. It is rather curious that even in the United States mechanical integrators have found favor only in recent times; there seems to have been a feeling among shipbuilders that any method so easy and rapid as ship computation by aid of integrators must be essentially untrustworthy.

Having dealt with the general design of ships, the author takes up the extremely important problem of bilging, now more than ever important in the days of the mine and torpedo. For this purpose the author uses a method that he calls the lost buoyancy method. The fundamental idea has long been known and used, since the readiest and best way of dealing with a ship which has large compartments broken open is to consider that it is a new ship lacking those compartments. The author, however, extends the principle to include all water admitted from the sea in consequence of injury or large leakage and develops a semi-logical method of computation which under proper control can be made to give results that are true and sufficiently accurate; the accuracy is probably at least as good as our knowledge of conditions. In this chapter the author shows up the pernicious effect of longitudinal bulkheads and attributes the sudden loss of the *Lusitania* and the *Empress of Ireland* to the existence of such

(*Continued on page* 174)

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

CONDUCTED BY JAMES L. BATES

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

Corrosion of Dissimilar Metals Under Water

Q. (1112).—What action takes place on a cast-iron propeller in salt water, when a wooden vessel is fitted with bronze rudder pintles, gudgeons, plates, etc.? Is it best to install all underwater work in iron to get away from the galvanic action between iron, bronze and salt water? Has practice shown that bronze fittings corrode the iron wheel more than when iron fittings are installed? C. R. W.

A. (1112).—When dissimilar metals in direct contact or in close proximity are immersed in sea water, corrosion of the more electro-positive metal due to galvanic action usually results, while the more electro-negative one will be protected. Such action is essentially the same as that which takes place in the voltaic cell where iron and copper are placed in a weak acid with the resultant rapid corrosion of the former metal. The iron or corroding metal is termed electro-positive and the copper electro-negative. Copper, lead, tin and brass alloys are all electro-negative to iron.

The following list of metals as given on page 30, "The Corrosion and Preservation of Iron and Steel," by Cushman and Gardner, is arranged in the order of their diminishing solution tensions:

Magnesium	Nickel
Zinc	Lead
Aluminum	Copper
Cadmium	Tin
Iron	Antimony

A metal at any point in this series is electro-negative to those preceding and electro-positive to those following it.

As to the extent of damage to vessels due to galvanic action, data are somewhat conflicting. Experiment and experience have shown widely divergent results, due possibly to causes mentioned later.

On page 151 of *The Shipbuilding and Shipping Record* of February 17, 1916, is described the remarkable instance of the schooner yacht *Sea Call,* which sustained such serious damage due to galvanic action that she was dismantled and scrapped within three months after launching. The characteristic features responsible for this corrosion were a forged steel stem, cast steel sternpost, and rudder framing, bronze propeller, tinned, and chrome vanadium steel bulb angle framing with monel metal plating except the two upper strakes, which were steel. The rudder was also covered with monel metal plates. Monel metal rivets were used in the plating, except in a few instances where by mistake steel rivets were used. The failure or total disappearance of one of these rivets led to the discovery of the serious damage from corrosion. It was found that severe corrosion had taken place on the forged steel stem, cast steel rudder and stern frames, and the steel bulb angle framing. The monel metal was not affected in any way.

United States naval practice formerly required the fitting of zinc plates on rudder, sternpost, shaft struts and shaft tubes, and zinc rings around composition sea chest openings. The zinc rings have been superseded by medium steel rings and doubling plates, which serve to provide an excess amount of electro-positive material which can be readily removed when corroded. The use of zinc plates on rudder, sternpost, etc., has been abandoned generally, since experiment has shown no injurious effect due to their omission.

As between naval practice and the case of the *Sea Call* there is, admittedly, a wide range. In the former the exposed area of the monel metal was very large compared with the steel, while in the latter the exposed area of steel is overwhelmingly in excess of that of brass alloys. Also the fact that in naval practice the underwater portion of vessels is covered with an anti-corrosive paint containing a large percentage of zinc oxide may prove a contributing factor to the preservation of the steel from corrosion.

In view of the foregoing it is not improbable that the relative areas of exposed surfaces of the dissimilar metals is the principal factor governing galvanic action. This view seems to be supported by Sir William White in his "Manual of Naval Architecture," pages 433 and 434 of the 1900 edition. Further, temperature and salinity of the water also influence corrosion and it sometimes occurs between different portions of the same metal due to lack of homogeneity of the material.

In the case of a wooden vessel under the conditions named, and especially if the outer propeller shaft bearing is or has an exposed bronze bushing, corrosion of the propeller will in all probability result. The extent to which, and the rapidity with which, this would take place is problematical, being influenced by certain of the factors enumerated above as well as by others, such as the quality of the cast iron in the propeller itself.

Underwater work is frequently installed in cast iron, even to the tail shaft bearing and rudder gudgeons. For coastal work where the navigation of muddy rivers is necessary and sand likely to enter the bearings, cast iron bushings are considered good practice, having longer life than lignum vitae staving. Such an installation would, of course, obviate galvanic action.

Practice has demonstrated that the iron wheel will suffer more from corrosion when in the presence of bronze than iron fittings.

Design Curves for Open Motorboat

Q. (1116).—I would like to know if you can give me an example, showing how much should be added to wave form curves for waterline and curve of areas for an open motorboat of the following dimensions:

Length overall	25 feet
Length on waterline	22 feet 6 inches
Beam	7 feet
Draft, to rabbet	1.25 feet
Speed, per hour	9 miles
Midship section area	4.7
Coefficient	0.61
Load waterline area	94 square feet
Load waterline breadth	6.15
Load waterline coefficient	0.68
Prismatic coefficient	0.68
Block coefficient	0.66
Keel, sided, 2¾ inches, molded	6 inches

How could I obtain tables of area curve factors? J. S.

A. (1116).—From the information furnished, the displacement, without appendages, is:

$$\frac{22.5 \times 6.15 \times 1.25 \times .414}{35} = 2.05 \text{ tons, in salt water.}$$

The speed, 9 miles (nautical miles assumed), gives for the

length suggested a value for the speed length ratio of 1.9. For this value the prismatic coefficient .68 suggested is permissible.

In determining the shapes of the curves of sectional areas and load waterline, several methods are available. Each has for its object the securing of a fair, easily driven form, and in order to accomplish this result the load waterline adopted must be suited to the curve of sectional areas. An improper relation between the two will usually result in difficulty in fairing the ends of the underbody.

Should you be interested in making a careful study of underbody forms from a mathematical standpoint, Admiral Taylor's method as described by him in a paper entitled "Calculations for Ships' Forms and the Light Thrown by Model Experiments upon Resistance, Propulsion and Rolling of Ships," presented at a meeting of the International Engineering Congress, 1915, in San Francisco, is of interest. This method is of especial value as illustrating the interdependence of the various elements of form upon each other and as providing a logical means of determining the effect upon all the other elements of the variation in the value of any one. For the development, however, of an individual body plan, the method is somewhat complicated and requires careful study and considerable experience in order to make its use with facility possible.

The method often followed by the writer consists in the reading off of functions for areas of section and load waterline offsets, based upon the area of midship section and load waterline beam, respectively, as unity, from carefully prepared standards. The proper point on the standards at which to read the functions is dependent upon the value of the prismatic coefficient.

For the standard referred to, see pages 187 to 190, inclusive, of *Shipbuilding Cyclopedia,* 1920 edition. Functions are obtained by extrapolation.

	Sectional		Load Waterline	
Station Number	Function	Area	Function	Breadth
0	0	0	0	0
1	.176	.83	.189	1.16
2	.349	1.64	.363	2.24
3	.514	2.42	.523	3.22
4	.661	3.11	.662	4.07
5	.787	3.70	.782	4.87
6	.884	4.15	.878	5.40
7	.947	4.45	.940	5.78
8	.978	4.60	.980	6.02
9	.997	4.68	.996	6.12
10	1.000	4.70	1.000	6.15
11	.996	4.68	1.008	6.20
12	.980	4.61	1.003	6.17
13	.947	4.45	.996	6.12
14	.888	4.17	.985	6.06
15	.788	3.70	.966	5.94
16	.655	3.08	.926	5.69
17	.491	2.31	.864	5.31
18	.329	1.55	.774	4.76
19	.190	.89	.659	4.05
20	.077	.36	.511	3.14

The displacement resulting is:

$$63.9 \times \frac{22.5}{20} \times \frac{1}{35} = 2.05 \text{ tons (by the trapezoidal rule).}$$

It will be noted that the block coefficient used in the first part of the discussion, viz., .414, is not that given among your data. Obviously it is impossible to have for the same boat values of .66, .68 and .61 for block, prismatic and midship section coefficients, respectively. This is because midship section coefficient $\times$ prismatic coefficient $=$ block coefficient. Inasmuch as .66 is a rather large value for the block coefficient in a boat of the type under discussion, and because .68 is a reasonable value for the prismatic coefficient of such a boat, the latter has been adopted and a value of .414 for the former has been derived by the use of .68 $\times$ .61 for prismatic and midship section coefficients, respectively.

You will note also that the waterline coefficient works out to a value of .787. This is larger than that suggested.

In a similar manner to the above the sectional area and load waterline curves of a boat of known characteristics may be used as standards.

As an example of this method the following figures are given. They are based upon a boat which, while somewhat larger than that which you contemplate, is of good design and has given satisfactory results in the model basin.

	Sectional		Load Waterline	
Station Number	Function	Area	Function	Breadth
0	0	0	0	0
1	.110	.52	.133	.82
2	.258	1.21	.271	1.67
3	.415	1.96	.402	2.48
4	.569	2.68	.531	3.27
5	.698	3.28	.647	3.98
6	.808	3.80	.755	4.64
7	.894	4.20	.843	5.18
8	.953	4.48	.912	5.61
9	.988	4.64	.963	5.92
10	1.000	4.70	1.000	6.15
11	.993	4.67	1.018	6.26
12	.961	4.52	1.022	6.28
13	.903	4.24	1.010	6.21
14	.827	3.89	1.000	6.15
15	.743	3.49	.977	6.01
16	.648	3.05	.943	5.80
17	.549	2.58	.902	5.55
18	.454	2.14	.859	5.28
19	.360	1.70	.804	4.94
20	.270	1.22	.759	4.66

The displacement upon this basis would be about 2.01 tons, and the prismatic and load water plane coefficients, respectively, .663 and .768. This would, in the opinion of the writer, give you satisfactory results.

The above figures are based upon the assumption that a displacement of about two tons will be satisfactory. Should you desire to use a different displacement, it is suggested that the change be made in the draft and the midship section coefficient so as to permit the use of the values of the longitudinal and load water plane coefficients suggested above. The data for the curves of sectional area and load water plane shown above will then be applicable.

Design of Warships

(*Continued from page* 172)

bulkheads. This influence has long been known and was proclaimed time and again long before either ship was built.

The author, who has been a life-long student of the problems of submarines, gives a chapter on the buoyancy and stability of submarines by his constant displacement method, which gives certainty and simplicity to a discussion that is much more difficult than the corresponding discussion of surface ships.

During the war the author was a special expert to the Bureau of Construction and Repair of the United States Navy Department, and in his chapter on troop ships he gives the results of his study of the design of such transports and also of the adaptation of passenger ships to the same service. This latter matter has its own difficulties because passenger ships are purposely made tender so that they may be comfortable. Intact, they are safe in all weathers, but for troopers they must be able to meet some of the exigencies of warfare.

The license, which had to be obtained by every French vessel of over 100 tons gross prior to each voyage and by allied and neutral vessels trading with France and her colonies has been suppressed by a decree published on January 8.

PERSONAL MENTION

John A. Donald, dean of the Shipping Board commissioners, is spending a month's vacation in the Bahamas, with his wife and son.

Edward M. Hyzer, formerly general counsel of the Chicago & Northwestern Railroad, and more recently assistant general counsel for the United States Shipping Board Emergency Fleet Corporation, has been appointed general counsel for the United States Shipping Board vice Colonel Guy D. Goff, recently appointed as a member of the Shipping Board.

Harry Brown, formerly technical manager of the Bethlehem Shipbuilding Corporation, Ltd., Bethlehem, Pa., has been appointed manager of engineering and sales by the directors of the company. H. G. Smith, formerly manager of engineering, was elected assistant to the president, and W. F. Hartmann will succeed E. B. Hill as treasurer.

E. B. Hill, formerly treasurer of the Bethlehem Steel Company, Bethlehem, Pa., and of the Bethlehem Shipbuilding Corporation, Ltd., has been made vice-president of the latter and will be in charge of operations at the Fore River Works, Quincy, Mass. Mr. Hill succeeds J. W. Powell, who is to take up special work for the corporation.

Rear Admiral Albert P. Niblack, U. S. N., serving as naval attaché at London, has been appointed commander-in-chief of the American naval forces in European waters. This appointment carries with it promotion to vice-admiral. Admiral Niblack succeeds Vice-Admiral Harry McL. P. Huse, who has been in command of the United States forces in European waters for the last year. Admiral Niblack graduated from the Naval Academy at Annapolis in 1880, afterwards serving on the Pacific station and in exploration and surveying parties into Alaska for several years. In 1893, he was attached to the Atlantic squadron. From then until the Spanish war he served as naval attaché at Berlin, Rome and Vienna. He took part in the suppression of the Filipino insurrection, in campaigns at Manila, Iloilo, and Sebig Bay, and also in the Boxer campaign. At various times since then he has been in command of the *U. S. S. Iroquois,* of the Pacific squadron in 1906 and 1907, chief in command of ships at the Naval Academy, naval attaché of the American Legation at Buenos Aires, naval attaché at the American embassy, Berlin, fleet commander of the *U. S. S. Michigan,* in command of the 3d seaman regiment at Vera Cruz in 1914. In 1916 he graduated from the Naval War College and has since been a member of the general board. At the outbreak of the war Admiral Niblack was ordered to command division 1 and later squadron 1 of the Atlantic fleet. In November, 1917, he was placed in command of squadron 2, the patrol forces and the United States naval forces based on Gibraltar. He commanded the naval forces of the United States in the western Mediterranean until after the armistice and in the eastern Mediterranean and the Adriatic from January to March, 1919; on April 1, 1919, he was made director of Naval Intelligence of the Navy Department.

Vice-Admiral A. P. Niblack, U. S. N.

John B. Matthews, consulting engineer and surveyor, 24 California street, San Francisco, Cal., has just completed preliminary plans for an electrically driven passenger liner for the Oceanic Steamship Company, of San Francisco, Cal. Mr. Matthews' engineering experience began in 1901 when he worked as an apprentice in the machine and pattern shops and drafting rooms of the Pennsylvania Iron Works, Philadelphia, Pa. He remained here until 1905, when he went with the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., in the engineering department. During the three years he was with this company he completed a special course of studies at the University of Pennsylvania. From 1908 until 1913 Mr. Matthews had charge of the design of machinery at the Lake Torpedo Boat Company, Bridgeport, Conn. For the next two years he was submarine expert at the Brooklyn Navy Yard, as well as in charge of Diesel work and estimating on the battleships *California* and *New Mexico.* From June, 1915, to February, 1918, he was chief engineer of the Bethlehem Shipbuilding Corporation at the Moore plant, Elizabethport, N. J., engaged in designing, standardizing and supervising the construction of ship propelling machinery. Until February, 1920, he was consulting engineer for the Moore Shipbuilding Company, Oakland, Cal.

John B. Matthews

Edwin S. Carman, recently elected president of the American Society of Mechanical Engineers, was born in Prairie Depot, Ohio, in 1878. His high school and business education were supplemented by special instruction and studies in engineering at the Central Manual Training School, Cleveland, Ohio. He began his work in the shops of the Sun Oil Company, Toledo, Ohio, and four years later entered the engineering field with the American Machine and Manufacturing Company, Cleveland, Ohio. He was appointed chief engineer after two years in the engineering department. In 1908 Mr. Carman was engaged by the Osborn Manufacturing Company, Cleveland, to design, manufacture and build up a complete line of foundry molding machines. In 1913 Mr. Carman became directly associated with the Osborn Manufacturing Company as chief engineer in charge of engineering and manufacture of the machine division, and in 1916 he was elected a director and secretary. In 1917 he was appointed works manager of both the machine and brush divisions of the company. Mr. Carman has taken a very active part in the affairs of the American Society of Mechanical Engineers since his election to membership in 1917, and has also found time and opportunity to contribute to the advancement of his local and state engineering organizations.

E. S. Carman

Howard C. Higgins has opened at 17 Battery Place, New York city, a brokerage office for the sale, purchase and charter of vessels. For many years Mr. Higgins was superintending engineer of the Old Dominion Steamship Company. With the outbreak of war he became the authorized representative and district manager for the United States Shipping Board Emergency Fleet Corporation, first at the Newark Bay plant of the Submarine Boat Corporation and later at the Hog Island plant of the American International Shipbuilding Corporation. Mr. Higgins is a member of the Council of the Society of Naval Architects and Marine Engineers.

R. W. Levenhagen has recently been made vice-president of the Glidden Company, Cleveland, Ohio. He will be in charge of the auxiliary organization of this company. Mr. Levenhagen began his career in the paint and varnish industry twenty-five years ago with the Sherwin-Williams Company, Cleveland, Ohio, and continued with this company until his present connection. For several years past, he has been secretary of the Sherwin-Williams Company as well as vice-president and general manager of the Detroit White Lead Works, Detroit, Mich., and vice-president of the Martin-Senour Company, Chicago, Ill. Mr. Levenhagen's duty will be to direct the service of the Glidden Company to a higher degree of co-operation with dealers and manufacturers affiliated with the auxiliary organizations.

R. W. Levenhagen

H. B. Miller has resigned as director of the Division of Supply and Sales of the United States Shipping Board.

Captain E. W. Bonnaffon, Supply Corps, United States Navy, formerly assistant to the director of the Bureau of War Risk Insurance, has been ordered to duty with the Shipping Board to become the successor of Mr. Miller as head of the Division of Supply and Sales.

Richard M. Semmes has been appointed director of the operating division of the Shipping Board in the Seattle district, vice Dudley W. Burchard, retired. Mr. Semmes served with the Admiral Line for years in San Francisco and Seattle, becoming its general freight and passenger agent. He managed the Independent Steamship Company, operating between Seattle and Southwestern Alaska, and served later as the traffic adviser of the Alaska Territorial Shipping Board. He gave Congress valuable help in the framing of the new merchant marine act. When his appointment as successor to Mr. Burchard was announced recently the news caused general satisfaction in the shipping world of the Seattle district.

Wilson Porter Smith, who is now associated with the United States Mail Steamship Company, Inc., 45 Broadway, New York, is in direct charge of the re-conditioning of the S. S. *George Washington,* flagship of the line, and the S. S. *Mount Vernon,* ex-*Kronprinzessin Cecilie,* with offices aboard the S. S. *George Washington,* lying at Commonwealth Dry Dock, South Boston, Mass. Mr. Smith designed the interiors of the public rooms and staterooms on the S. S. *Aeolus,* the re-conditioning of which at the plant of the Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md., was described in our last issue.

Alexander McDougall, president of the McDougall-Duluth Shipbuilding Company, Duluth, Minn., who has been in Europe on a business trip, was inadvertently referred to on page 93 of our January issue, as Harris McDougal. Captain McDougall is arranging for the construction of a special type of craft known as seagoing canal boats and lake canalers, models of which were exhibited at the recent Marine Exposition in New York.

D. B. Carson has been appointed Cleveland district sales manager for the Tacony Steel Company, Philadelphia, Pa.

D. J. Crowley has been appointed Michigan sales agent of the Tacony Steel Company, of Philadelphia, with offices in the Dime Bank Building, Detroit, Mich.

Frank Thornton, Jr., chief engineer of the Westinghouse Electric Products Company, has been appointed manager of the electric heating engineering department of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

OBITUARY

John McInnes, superintendent of the Bath Iron Works, Bath, Maine, died on January 22, at Port Glasgow, Scotland, as the result of an operation. Mr. McInnes has been with the Bath Iron Works for over twenty years, and at the time of his death was spending the holidays in Scotland with his wife.

B. Frank Wood, one of the leading yacht builders on the Atlantic coast, died recently at his home on City Island, New York, at the age of sixty-six years. He was born in Manhattan and at the age of four years went with his father, also a boat builder, to City Island. The business, established in 1861, came into his hands at the retirement of his father about thirty years ago. Many famous yachts have been turned out in his yards, among them being *Irondequoit,* a Canada cup winner; *Felseen,* at one time the fastest steam yacht afloat, and the speed boat *Dixie.*

Ship Data Sheets

A special loose-leaf binder in which to present ship data has been developed by the New York office of the Federal Shipbuilding Company. Until this book was issued in December, 1920, no standard specification form had been arranged by any shipbuilding company for the general information of those interested in technical descriptions of various types of vessels. Profile and deck plans of different types of vessels built by the Federal yard are arranged on inserts and the principal characteristics of the hull construction, machinery, cargo hold arrangements, handling equipment, bunker and tank capacities and locations, tonnage ratings, oil specifications and general remarks on crew and officers' quarters and the like, are given on a page facing the plans so that reference may readily be made from one to the other.

General specifications of the Scotch marine boilers built by the Federal yard have been standardized in a similar manner, so that the description of the construction and fittings of a typical bare boiler, as given in the book in conjunction with a table stating the diameter, number of furnaces and square feet of heating surface for each size, adequately describes every size boiler produced by the company.

Ship machinery details are adaptable to this same form of presentation and folders describing propelling units as well as new ship designs will be issued frequently by the company. These will all be arranged for insertion in the binder.

Shipbuilding and General Marine News

Contracts for New Ships — Shipyard Improvements — Engineering Projects—Improved Appliances—Personal Items

WATERWAY AND TRADE BOOM FORECASTED AS OUTCOME OF CONVENTIONS

Mississippi Valley and South Atlantic States Associations Hold Stirring Sessions at Washington—Forward Movement the Keynote

The development of the internal waterways, the growth of foreign trade, and the balancing of foreign exchange are the three great objects for which we should strive, according to President H. H. Merrick, of Chicago, in his opening address at the second annual convention of the Mississippi Valley Association held at the Willard Hotel, Washington, D. C., January 19 and 20. President Merrick presided at the session.

J. E. Smith, of St. Louis, stated that it was to the commercial interest of the twenty-seven states embraced in the Mississippi Valley to secure the development of a national waterway system. He claimed that 54 percent of our population resided in these states, and that they had a majority of votes in both houses of Congress. Colonel H. H. Haines, of Galveston, Tex., called attention to the fact that the state of Maine, by water transportation, could put its products into Texas cheaper than the states of the Mississippi Valley. He explained the advantage of combining grain with the cotton shipmens from the south and pointed out that it was only 700 miles from Kansas to Texas, as compared with 1,500 miles from Kansas to New York.

Among the other speakers were J. B. Morrow, executive secretary of the association, who urged the administration and strengthening of the Merchant Marine Act of 1920, and J. E. Bollhorn, of Milwaukee, who told of the great terminal and port facilities that Milwaukee was preparing and advocated the development of the St. Lawrence River to connect the Great Lakes with the sea.

A banquet was held on Wednesday evening at the New Willard Hotel, at which short talks on the "Valley Idea" were given by representatives from the various states in the Mississippi Valley. Over 100 congressmen were present.

SOUTH ATLANTIC STATES ASSOCIATION

The United States Shipping Board, in its sales policy, should give the most serious consideration to the establishment of new trade routes, according to President Matthew Hale, of the South Atlantic States Association, at the annual convention of that body held in the Hotel Washington, Washington, D. C., on January 19. Mr. Hale, who is also president of the South Atlantic Maritime Corporation, presided at the convention and in the course of his address outlined the objects of the association, explaining the educational work to be done in regard to the development possibilities of southern ports, and the data and information to be secured and made available by their Washington office.

A resolution was adopted asking all southern railroads to declare their stand on export rates for South Atlantic ports. The prospect of a combination of thirty-two states was seen when it was advocated that it would be greatly to the benefit of the South Atlantic states to join forces with the Mississippi Valley Association.

Extending Graduate Engineering Research Work

To assist in the conduct of engineering research and to extend and strengthen the field of its graduate work in engineering, the University of Illinois maintains fourteen Research Graduate Assistantships in the Engineering Experiment Station. Two other such assistantships have been established under the patronage of the Illinois Gas Association. These assistantships, for each of which there is an annual stipend of $600 and freedom from all fees except for matriculation and diploma fees, are open to graduates of approved American and foreign universities and technical schools who are prepared to undertake graduate study in engineering, physics, and applied chemistry. Additional information may be obtained by addressing the director.

ENGINEERING LECTURES

Members of Ocean No. 80 Have Instructice Programme

Members of Ocean Marine Engineers Beneficial Association, No. 80, are taking an active interest in the course of lectures being conducted in conjunction with the Tuesday evening meetings of the association at 15 Whitehall Street, New York City. The educational department of the association has been successful in arranging a program of speakers of recognized ability, and fully 200 members, representatives of steamship companies and other marine interests are attending the sessions. On January 18, Mr. Eskil Berg, of the General Electric Company, spoke on the subject of "Marine Steam Practice." Mr. Berg had delivered previous lectures to the engineers and he was given an enthusiastic reception. He praised superheat and the Diesel engine, and in his reference to the former subject, emphasized the point that he was not referring to 50 degrees, but of 200 degrees when he mentioned superheat.

At the previous weekly meeting on January 11, J. A. Barnes and G. E. Kershaw, of the Locomotive Superheater Company, gave a joint illustrated lecture on superheat. Mr. Barnes dwelt chiefly on superheat as a means of providing a more efficient power plant and because of which a saving of fuel and water may be accomplished and in the design of new equipment engines and boilers of a smaller size for a given horsepower may be provided. Mr. Kershaw spoke of the practical operation and care of this equipment and answered in detail a number of questions from various engineers present.

The programme thus far prepared by the educational department included the following:

February 1—Mr. J. B. Bassett, General Electric Company, subject, "Diesel Electric Drive."

February 15—Mr. Ernest H. B. Anderson, Parsons Marine Steam Turbine Co., Ltd., subject, "Marine Turbines and Gearing."

March 1—Mr. L. W. Williams, Shipley Construction & Repair Company, subject, "Marine Refrigeration."

Completes First Voyage

The steamship Leda, 321 feet long, which was built by Sir W. G. Armstrong, Whitworth & Company, Ltd., for Det Bergenske Dampskibsselskab, Bergen, has completed her first round voyage between Newcastle and Bergen. She is a passenger vessel.

COMPETITIVE BIDDING URGED ON SHIPPING BOARD TO CUT REPAIR COSTS

Shipping Men Claim Bills Totaling $6,000,000 Are Still Unpaid—Suggest Abolishment of the "Time and Material" Contracts

Although called together by Commander R. D. Gatewood, head of the Bureau of Construction and Repair of the U. S. Shipping Board, to explain why the prices of materials used in ship repair work seemed excessive, the ship repair men took a turn at showing Commander Gatewood and Commissioners Donald and Thompson how the Shipping Board could economize by abolishing the "time and material" basis for contracts and placing all repair work on a competitive basis.

Commander Gatewood bluntly told the score of ship repair men that the time had come when they must submit smaller bills for work done. He painted a dreary picture of the future of the country's merchant marine if this was not done and pointed out that the work could be done more cheaply in Europe.

In reply E. P. Morse pointed out to the commissioners that the repair men were suffering many injustices at the hands of the Shipping Board. William H. Todd, president of the Todd Shipyards Corporation, followed Mr. Morse, and stated that all of the repair people in this district, both large and small, have been very unjustly dealt with by the Board to the extent that their bills, totalling $6,000,000, are still unpaid. Commander Gatewood agreed that this figure was not under-estimated.

Mr. Todd opened the eyes of the two visiting commissioners when he told how, after his concern had finished repairs on the steamer *Hansemund*, the contract having been awarded on a competitive basis, the Todd bid being $39,000 as against the next bid of $98,000, the Shipping Board failed to take delivery of the vessel for nearly a month later. As a result, the vessel broke from her moorings in a storm and did damage to the Todd yard amounting to $30,000, another bill still awaiting payment. This contract was awarded with a penalty clause of $5,600 for every day the repair yard held the vessel beyond the contracted time.

Mr. Todd pointed out in reply to Commissioner Donald's comment that he thought it unfair that twenty-five per cent additional charges be made for painting a steamer while in dry dock, that the Shipping Board should handle the painting the same as private owners do. That is, deal with the painters direct and thus eliminate additional overhead.

In reply to the hint of Commander Gatewood that the Shipping Board may be compelled to invite bids from shipyards outside of New York, Mr. Todd said:

"That suits us. Give us all a chance to bid. That's all I'm asking. We went to Halifax at the request of the Shipping Board, and bid against yards up there for a ship. We got the job and brought it down to New York.

"Only recently bids were opened on a vessel where bids were confined to yards on the Atlantic coast possessing graving docks. The result being that our Robins yard was successful in getting the job, their bid being $475,000 and 90 days time as against the bid of the Newport News Shipbuilding Company's bid of $576,500 and 135 days time."

Mr. Todd took exception to the statements that work could be done more cheaply in Europe and that repair costs in this district are higher than in other districts. He added:

"When you speak of costs in Great Britain, let me say that we can compete with Great Britain right now. You know, Mr. Gatewood and Mr. Donald, that I've been hollering to you for competitive bidding for a long time. You say, Mr. Gatewood, that repairs cost too much, there is absolutely no question that this is the case. The greatest waste, in my opinion, is the manner in which the repairs are ordered and handled by your own organization.

"Just recently you stated to us that you were compelled to give out a big repair job on cost plus basis because the operators were not able to prepare intelligent specifications. Surely, the repair people are not to be blamed for that. It would be better for the Board to wait a few days longer, get the specifications complete and then go into the market and get competitive bids from everyone.

"You are sending tankers to people who do very little work and do not get any of the work they bid on because their prices are so high. Yet the tankers are sent to these firms on a cost plus basis. Simply because their commercial rate is a trifle lower than some of the consistent bidders on your competitive works."

Commander Gatewood said the reason the tankers were sent to the yards referred to was because of their proximity to the oil terminals. In reply Mr. Todd said:

"You know we have yards close by. One yard is not more than an hour and a half away. Let me tell you, gentlemen, that this time and material basis is not the way to reduce the cost of repairs."

"You know, Mr. Donald, if you had a $60,000 job, you'd ask for bids, wouldn't you?"

The commissioner replied it would be a matter for the underwriters if a hurry job was necessary, as in the case of an accident. To the amusement of those present, the veteran shipping man agreed with Mr. Todd that the underwriters would ask for competitive bidding.

Commissioner Gatewood and the commissioners admitted that the system of paying the Shipping Board bills was unjust and worked a great hardship on the repair plants.

"We have bills with you people involving great sums of money since last August." Mr. Todd added, "They are still unpaid. After they have been O.K.'d we get them back months later, with requests for routine details. I don't think that's good business. Don't you think, gentlemen, we ought to be given some consideration in getting our money. Do you think we can work cheaper when we have to wait so long for payment? We can't tell our men to wait six or eight months. I think it would be a good thing if the operators of your ships had the repairs done and paid the bills."

Following Commander Gatewood's announcement that he would look for new rates for material, Mr. Todd said:

"Does that mean you want us to reduce wages? If so, the reduction of wages or overtime of our employees is the farthest thing from my mind. Give me the interest on the money that you owe the men in this room and I'll consider giving you all the material for nothing."

The ship repair men said they were glad that Commissioners Donald and Thompson were at the hearing and expressed their appreciation of the open-mindedness of the commissioners. The small repair men said that while the difference of opinion was between the Board and the bigger plants they felt the industry as a whole would benefit from a general airing of the situation.

BRITISH TANK PRICES

That tonnage prices abroad are very little if any more attractive than American figures is indicated in latest official quotations which offer three British tank steamers now under construction in English yards at £45 per deadweight ton for delivery in May, £43 for delivery in June and £41 for delivery in July.

The vessels are 8,800 deadweight tons, and the price per ton at the present rate of exchange is approximately $166.50 as compared with prices for Shipping Board vessels quoted at from $165 to $185 per ton.

MOTOR SHIP LAUNCHED

The London & Montrose Shipbuilding & Repairing Company, Ltd., recently launched the steel motor coasting vessel *Yuletide* which they have built to the order of A. Besse, Esquire, of Aden, for Messrs. J. Stone & Company, of London. The vessel is 132 feet long, of special design, with large carrying capacity, and is equipped with a single screw Beardmore oil engine of 200 brake horsepower.

NAVAL SOCIETY ISSUES BULLETIN NO. 4

The Society of Naval Architects and Marine Engineers, 29 West 39th Street, New York City, has issued Bulletin No. 4, in which it places a number of new projects before its members. Included in these are the establishment of an employment bureau through which the society is prepared to assist its members in this respect.

FERRYBOAT CONTRACT IS AWARDED STATEN ISLAND SHIPBUILDING COMPANY

Winning Bid $736,430—Sum of $56,900 Asked By Commissioner Whalen to Rebuild The Steamer Mayor Gaynor

Grover A. Whalen, Commissioner of Plant and Structures, New York, on January 19, awarded the contract for the building of a 2,000-ton steel, screw ferryboat for the Staten Island Municipal Ferry to the Staten Island Shipbuilding Company, New York. The bids received were:

Standard Shipbuilding Corporation..	$775,000
United States Steamship Company..	744,700
Staten Island Shipbuilding Company.	736,430

"The persistent rejection of bids has lowered the price for this boat nearly $100,000," said Commissioner Whalen. "Bids have been received five times. Each time I have felt that the best interests of the city required the rejection of the bids." The record of the bids received is as follows:

Date	Staten Island Shipbuilding Co.	United States Steamship Co.	Other Bids
Oct. 11	$827,900	$916,835	$896,000 (Tebo) 947,666 (Newburgh) 1,040,000 (Bethlehem)
Nov. 1	822,000	812,400	875,000
Dec. 9	795,300	789,500	.....
Dec. 29	769,500	769,000	875,000 (Bath)
Jan. 18	736,430	744,700	775,000 (Standard)

"The lowest bid received on this bidding is $91,470.00 below the lowest bid received on October 11, which is a reduction of 11½ percent in the cost of the new ferryboat. This verifies my judgment that the dropping in costs would be reflected in new bids and that the city would save a substantial sum by readvertising the contract.

"The new boat is to be delivered in 275 consecutive calendar days."

$56,900 FOR REPAIRS

In a letter to the Board of Estimate and Apportionment, dated January 10, 1921, Commissioner Whalen made application for the issuance of corporate stock (revenue producing) in the amount of $56,900, for the reconstruction of the ferryboat Mayor Gaynor, so as to make it a serviceable craft. It is further requested that $28,615 of this amount be assigned to personal service schedules and permission is also asked to expend $30,285 of this fund for the purchase of the materials for this work and for contract and open order service in connection with it. Commissioner Whalen states that as a result of the survey made, with a view to determining how to make the boat serviceable, he finds that it can be expected to render good service after the following reconstruction work is done; rebuild boilers A and B; relocate and rebuild boiler C; install a fourth boiler, adding 716 horsepower; reconstruct coal bunker, hatchways, etc.; make additions and alterations to pipe systems, valves, etc., reconstruct ballast system, install new propellers and construct 400 additional seats. The work will be done at the Municipal shipyard at St. George, S. I., with the exception of the casting of new propellers and their installation, which will be done by contract.

Foreign Launchings

The steamer *P. L. M.* 23, the fourth of eight similar vessels constructed by Sir Raylton Dickson & Company, Ltd., was launched from their Cleveland Dock Yard, Middlesbrough, on December 23, 1920. The ship is for La Scapasrie des Chemis de Fer de Paris a Lyon et a La Medeteranneanoe, whose ship business is managed by their subsidiary company, La Societe Nationale d' Affretements. The vessel is 400 feet long, of a deadweight carrying capacity of about 8,900 tons on a light draft of water. Quadruple expansion engines placed aft, having cylinders 23, 32½, 47 and 68 by 48 stroke, supplied with steam by three large single ended boilers having Howden's system of forced draft will be fitted in this vessel and the three sister ships by the North Eastern Marine Engineering Company, Ltd., Wallsend-on-Tyne, while the remaining four vessels will be similarly engined by Richardsons, West Garth & Company, Ltd., Middlesbrough.

Messrs. Harland & Wolff, Ltd., have launched from their Govan shipyard the oil barge *Britmex Number* 11 for harbor and river use, built for the British, Mexican Petroleum Company, Ltd. The boat is 155 feet overall in length and is similar to several others previously built by Harland & Wolff, Ltd., for this company, having all modern equipment.

BUSINESS NOTES

The Mesta Machine Company of Pittsburgh, Pa., announces the opening of a branch office at Chicago, Ill. The offices are temporarily located in the Railway Exchange Building, but will be moved into permanent quarters in the McCormick Building after April 1. The Chicago office will be in charge of Mr. C. J. Mesta, 2nd vice-president of the company. Messrs. W. R. Dawson and R. W. Schutte will be transferred from the Pittsburgh offices to Chicago. The company has recently opened offices in the Singer Building, New York City, in charge of Mr. M. M. Moore who was formerly export sales manager. The company will also retain its office in the Munsey Building, Washington, D. C.

The Larko Range & Manufacturing Corporation has purchased the plant and range business of the Cochran Manufacturing & Forge Corporation at 78th Street and Woodlawn Avenue, Chicago, Ill. The Cochran Corporation and its forge business is now being incorporated as the Great Lakes Forge Company in greatly enlarged quarters at 119th and Racine Avenue.

The Chicago Pneumatic Tool Company announces the appointment of R. F. Eissler as assistant to the vice-president with headquarters at the company's new office building at 6 East 44th Street, New York City. W. C. Straub, formerly district manager of the New Orleans branch, has been appointed district manager of the Pittsburgh branch, succeeding Mr. Eissler, and Ross Wyeth, formerly attached to the Pittsburgh branch, has been appointed district manager of the New Orleans branch succeeding Mr. Straub.

Manager Charles R. Page, of the American Marine Insurance Syndicates, announced that the syndicates have opened an office in Philadelphia, located in the building of Brown Brothers at Fourth and Chestnut Streets. This office will be in charge of Surveyor J. H. Meseroll, who was recently attached to the staff in the New York office. Plans are also under way for the opening of offices in Boston and Norfolk.

Pollak Steel Company Promotions

At a recent meeting of the board of directors of The Pollak Steel Co., D. E. Sawyer was again elected General Sales Manager for the year of 1921 and is located, as in the past, at the New York office of the Company.

S. K. Morrow, formerly manager of operations, is now manager of sales for the three plants, with the offices at Cincinnati works.

C. G. Talbott, formerly assistant manager of operations, is now manager of rolled products for the Marion plant.

A. C. Weihl, for several years superintendent of Cincinnati plant, is now general works manager in charge of operations and productions of the Cincinnati, Chicago and Marion plants.

V. W. Prather, formerly cost auditor for Cincinnati plant, is now general cost auditor of three plants.

TRADE PUBLICATIONS

Multiwhirl Subcooling Condenser.—A bulletin has been issued by the Griscom-Russell Company, New York, describing multiwhirl subcooling condensers designed for use in connection with the refining and subcooling of gasoline and kerosene.

Dodge Heavy Oil Engines.—The Dodge Sales & Engineering Company, Mishawaka, Ind., has issued a catalogue containing an illustrated description of the various types and sizes of Dodge heavy oil engines, together with their application to fishing boats and tugs.

The P. & H. Chronicle.—A catalogue issued by the Pawling & Harnischfeger Company, Milwaukee, Wis., gives the story of the foundation and development of the company. Photographs of the personnel and of the plant, as well as of the products, give an idea of the organization and its work.

Valves and Fittings for Ships.—What is in effect a complete ship handbook has been published by the Crane Company, Chicago. This book includes specifications, drawings and special tables of information for practically every type of valve that might have a use in merchant marine or naval service.

Whitlock Cordage.—A complete history of the equipment of the Whitlock Cordage Company, New York City, is given in a pamphlet recently sent out by this company. Details of the manufacture of different kinds of rope and cord are described and illustrated, together with the price schedules for these products.

Single and Multiple Carbon Dioxide Units.—The Ushling Instrument Company, New York City, has re-designed the carbon dioxide equipment known as style U. Construction details and the method of operating the new apparatus are described in Bulletin 111, which has been published by this company for distribution.

Marine Machinery.—The Kearfott Engineering Company, Inc., New York, has issued a pamphlet outlining the service which the consulting staff of this company is prepared to give in connection with marine machinery installations, as well as the types of mechanical equipment that the company is in position to supply.

Dexter Valve Reseating Machine.—Three types of Dexter valve reseating machines are described in a catalogue issued by the Leavitt Machine Company, Orange, Mass. The three types have been designed for receding globe valves and gate and pump valves. Complete illustrated descriptions of the construction and operation of each, as well as specifications and prices for the various sizes, are given.

Oil and Gasoline Storage Systems.—A loose-leaf catalogue made up from descriptive bulletins has been issued by the Wayne Oil Tank & Pump Company, Fort Wayne, Ind. Oil and gasoline storage systems, oil filtration outfits, oil-burning systems, furnaces for metal melting, forging and heat treating are described in detail. Specifications and illustrations are given of practically all the standard products of the company.

History and Development of New York Shipbuilding Corporation.—The American International Corporation, New York, has published a bulletin describing the New York Shipbuilding Corporation at Camden, N. J., which is the largest self-contained plant of its kind in the world. Designed primarily for the construction of large passenger-carrying vessels, the expanded facilities of this yard are contributing to the American merchant marine the most important group of ocean liners now being built for the merchant fleet. Together with this construction, the yard is engaged in building naval vessels. The history of the plant from its foundation, the problems met and overcome by the early organization, and the records accomplished under the stress of war demands are outlined.

NEW INCORPORATIONS

S. S. Cuba, Inc., Wilmington, Del.—To own and operate boats; capital, $1,500,000.

Bay Towing Company, Galveston, Tex.; capital, $100,000; incorporated by W. D. and E. D. Hadden, J. R. Guyton.

Starkey & Cadmus, Norfolk, Va—Ship chandlery; capital, $50,000; incorporated with C. E. Cadmus, president; Thomas Starkey, secretary.

Dobson Raft and Lifeboat Corporation, Boston, Mass., to build rafts and lifeboats; capital, $200,000; by Robert A. Dobson, James R. Glassford and E .W. Flint.

Clarkson Coal & Dock Company, Wilmington, Del.; capital, $5,000,000; by C. T. Cohee, C. B. Outten, S. L. Mackey.

Delaware River Towing Line, Inc., Wilmington, Del., to build, own and operate boats; capital, $150,000.

Detroit Export Finance Corporation, Wilmington, Del., general export and import business; capital, $10,000,000.

Panamanian Ship Corporation, New York, incorporated with a capital stock of $20,000 by E. R. Clare, C. E. Willis and D. Woodhams, 17 Battery Place, New York.

The Atlantic-Pacific Manufacturing Corporation, Brooklyn, N. Y., life-saving equipment; capital, $75,000; by E. W. and C. M. Skoldberg and G. Swanson, 30 Prospect Park, Brooklyn, N. Y.

Gillespie Steamship Corporation, Manhattan, capital $250,000, by George S. Brengle, East Orange, N. J.; Charles F. Quarteill, Brooklyn; P. J. R. McEnlingart, New York.

Goodrich Transit Company, Wilmington, Del. boats; capital, $1,250,000; T. L. Croteau, M. A. Bruce, S. E. Dill.

Netherlands Trading Society, Manhattan, ship brokers; capital, $10,000; H. Deleeuw, E. T. McLoughlin, H. Rosenstein, 523 Metropolitan avenue, Brooklyn, N. Y.

Pamico Transportation Company, Wilmington, Del., boats; capital, $1,500,000; T. L. Croteau, S. E. Dill, A. M. Hoven.

Pensacola-Cuban Steamship & Trading Company, Pensacola, Fla.; capital, $150,000.

S. C. Loveland Company, ship brokers, $250,000; T. L. Croteau, M. A. Bruce, S. E. Dill, Wilmington, Del.

Pacific Ports Service Corporation, wharfage and berthing of steamships, $100,000; T. L. Croteau, M. A. Bruce, S. E. Dill, Wilmington, Del.

Kingston Dry Dock & Construction Company, Kingston, N. Y., 5,000 shares preferred stock, $100 each; 5,000 common, no par value; active capital, $525,000; G. A. Fagan, E. Salisbury, M. E. McGuiness, Kingston, N. Y.

Thomas Line, Manhattan, N. Y., steamship agency, $20,000; G. Painter, H. A. Smith, H. S. Thomas, 163 Eastern Parkway, Brooklyn, N. Y.

Whipple Ship Corporation, Wilmington, Del., the transportation of passengers or freight by water; capital, $100,000.

Truxtun Ship Corporation, Wilmington, Del., transportation of passengers or freight by water; capital, $100,000.

Henn, Vandenberg & Company, Manhattan, ship chandlers, $25,000; A. Henn, Jr., J. Gillespie, E. C. Hadler, 553 Gilmore street, Brooklyn, N. Y.

James E. Kelly, Manhattan, stevedoring, $5,000; E. P. Shell, C. H. and J. E. Kelly, 800 President street, Brooklyn, N. Y.

Portuguese Line, Manhattan, navigation, $5,000; L. W. Simmons, H. P. Pieper, A. F. Egeltropp, no address given.

South Jersey Supply & Transportation Company, 423 Market street, Camden, N. J., transportation business; capital, $125,000.

American-Machado Turbine Corporation, Wilmington, Del., manufacture of turbine engines, etc.; capital, $1,000,000.

The Seaboard & Inland Barge Company, New York, formed by a merger of the Inland Barge Company and the Seaboard Barge Company; capital, $1,000,000; to construct barges and other vessels and operate a general shipbuilding plant. M. and J. Tracy and C. L. O'Connor, 1 Broadway, incorporators

I. H. Aiken Transportation & Towing Company, Pensacola, Fla.; capital, $250,000; Alexina G. Aiken, president; Isaac H. Aiken, vice-president; Thomas W. Saltmarsh, secretary-treasurer.

Atlantic & Gulf Exporting Company, Jacksonville, Fla.; capital, $2,000,000; W. B. Gillican, president, New Orleans, La.; John H. Powell, vice-president, Jacksonville, Fla.; H. L. Richmond, secretary-treasurer.

Steel Products Corporation, El Paso, Texas; capital, $100,000; by J. H. Sanford, Jr., and E. L. Fugale, El Paso, to manufacture iron and steel specialties.

CAPITAL INCREASES

Tebo Yacht Basin Company, Brooklyn, N. Y.; to $1,000,000.

New England Forwarding Corporation, Manhattan, N. Y.; from $50,000 to $200,000.

Brewer Dry Dock Company, Elizabeth, N. J., $30,000 to $1,000,000.

Port Johnson Dry Dock Company, Port Johnson, near Bayonne, N. J., filed notice of change of name to Ballou Dry Dock & Repair Company, and increased capital from $20,000 to $500,000.

The Northwest Engineering Company, Green Bay, Wis., will increase its capital stock from $1,000,000 to $1,300,000. This company conducts a foundry and machine shop, manufacturing marine engines and equipment, as well as a ship construction yard and repair dock.

Whiting Foundry Equipment Company, Harvey, Ill., announces that it has changed its name to Whiting Corporation, increasing its authorized capital stock from $700,000 to $3,000,000. The Whiting Corporation remains under the same management and will continue the manufacture of cranes, foundry equipment and railway specialties as heretofore.

The Cowles Shipyard Company, Buffalo, N. Y., has increased its capital from $5,000 to $30,000.

Tampa Inter-ocean Steamship Company, Tampa, Fla., increased its capital from $300,000 to $500,000.

Beaumont Export & Import Company, Beaumont, Tex., increased its capital from $150,000 to $500,000.

CHANGE OF NAME

At the annual meeting of the stockholders of the Quaker City Steamship Company, general offices at Room 378, Drexel Building, Philadelphia, Pa., held on January 11, the stockholders voted to change the name of the company to the Tidewater Marine Company, and elected the following directors: George R. Dilkes, E. M. Fallon, L. Macandlish, M. L. Hutchinson and J. T. Manning, Jr.

Foreign Trade Development

Recently announced figures indicate that in ten years' time this country developed a merchant marine engaged in foreign trade from little more than 1,000,000 deadweight tons to 15,692,631 tons. In 1910 America's total merchant marine amounted to 11,262,123 deadweight tons, of which 1,173,776 tons were engaged in foreign trade. In 1917 our total tonnage was 13,306,556, of which 3,606,164 tons were engaged in foreign trade. The fiscal year ending 1920 show our total merchant marine to be 25,027,342 tons; of this, more than three-fifths engaged in foreign trade, or a total of 15,692,631 tons.

Motor Passenger and Cargo Ship Launched

The twin screw motor passenger and cargo vessel Margvana, built for the British India Steam Navigation Company, Ltd., was launched on December 24, 1920, from the Clyde home yard, Whiteinch, Glasgow, by Messrs Barclay-Curle & Company, Ltd. She is built to comply fully with the "International Convention" regulations for the safety of life at sea and her principal dimensions are: length, 450 feet, breadth, 58 feet, gross tonnage, 8,500 tons, deadweight carrying capacity, 10,500 tons. Efficient cargo handling gear is being provided with electric winches.

When completed the vessel will embody all of the most up to date features of the motorship. She is rigged as a two-masted schooner and to preserve the characteristic appearance of the vessels of the British-India fleet.

Marine Construction News of the Month

Ship Contracts—New Ship Concerns and Shipyard Improvements—Terminal Projects—Government Contracts

SHIPS AND SHIPBUILDING

Tug, Bridgeport, Conn.—The Bridgeport Dredge & Dock Company is reported to be in the market for a small tug to be used for towing in Long Island Sound.

Floating Equipment, Havana, Cuba.—The V. V. C. Sand & Construction Company, Egido, 2-A, Por Corrales, is in the market for floating equipment, including dipper dredges, barges and tugs.

Passenger Steamer, Vancouver, B. C.—A new steel steamer to carry 1,200 passengers, and with a speed of 14 knots, is to be built at a cost of $200,000 to $225,000, for the Union Steamship Company, it is reported.

Schooners, Maine.—It is reported that Crowell & Thurlow, Boston, Mass., will build several four-masted schooners at Boothbay Harbor and Rockland, and that tenders are out for several other large schooners to be built in other Maine yards.

Keels Laid for Steamers, Vancouver, B. C.—The keels of two new Government steamers, the Canadian Transporter and the Canadian Trader, were laid at the Coughlan Shipyards recently. Several hundred men are engaged at the yards.

Vessel Contract Awarded, Manitowoc, Wis.—A contract for the construction of a vessel for the American Sand & Gravel Company, of Chicago, Ill., has been awarded the Manitowoc Shipbuilding Corporation. Details concerning the boat are as yet unavailable for publication.

Steamers to Be Converted, Victoria, B. C.—Alterations for the conversion of the steamer Princess Adelaide, the first of the Canadian Pacific Railroad steamers to be converted into a coal burner because of the scarcity of fuel oil, are being made at the yard of Yarrows, Ltd.

Orders Placed for Suction Dredgers.—In the face of cancellations of contracts abroad, it is interesting to note that orders for six powerful suction dredgers have been placed by the Indian Government with two Renfrew concerns which specialize in the construction of vessels of this type.

Freighters, Germany.—It is stated that the Schichau Company, operating important shipyards at Danzig and Elbing, is building a number of new vessels for foreign account. The Elbing Schichau yards are busily engaged in the construction of freight steamers for Denmark, each of which has a carrying capacity of 3,000 tons.

Vessel Launched, Newark, N. J.—The steamer Sujerseyco was recently launched at the Port Newark yards of the Submarine Boat Corporation. Twenty-eight of the thirty-two vessels which the company is completing for its own account have now been launched, leaving four now on the ways.

To Enlarge Fleet, New York.—According to a report credited to Col. F. W. Fraley, Southwestern representative of the Sinclair Refining Company, that company will soon add nine new tankers to its fleet of about twenty of these vessels, with a view to increasing the importation of Mexican crude oil.

Steamer to Be Reconditioned, San Francisco, Cal.—Fletcher Munson, connected with the Hanlon Shipyards, has purchased the steamr Oakland from the Albers Steamship Company, and after an extensive overhauling plans to place the vessel in the copra-carrying trade between San Francisco and the South Seas.

To be Converted into Oil Tankers, Beaumont, Tex.—The Beaumont Dry Dock & Shipbuilding Company will convert the Ferris type hulls stored at Beaumont into oil tankers. Out of twenty-five of these bottoms stored at Beaumont, twenty-three are now at the yards of the Beaumont Dry Dock & Shipbuilding Company.

Activities at Oakland, Cal.—It is reported that the Moore Shipbuilding Company, Oakland, Cal., will shortly start work on three tankers of 76,000 barrels capacity for the Shipping Board, and that the concern is now in receipt of contracts for the building of several fuel carriers for the Standard and Union Oil Companies.

New Steamer Completed, Weehawken, N. J.—A new steel hull sightseeing steamer, the Visitor, has just been completed by the Weehawken Dry Dock Company for the New York Harbor Sight Seeing Company, with offices at 15 Park Row. The steamer is 100 feet long, 20 feet wide and 9 feet deep, and it is the intention of the owners to use her in daily trips around Manhattan Island.

Reconditioning Steamer, Antwerp, Bel.—The Canadian Pacific Ocean Services, Ltd., London, has contracted with the Antwerp Dry Dock & Engineering Company for the steamer Scandinavian, of 12,000 tons, to be overhauled and repaired and painted inside and out. The Melita, another of the company's big liners, is also reported to be at the Antwerp yard for extensive reconditioning.

Freighters, Oakland, Cal.—The two 14,500-ton deadweight freighters, Manulani and Manukai, building for the Matson Navigation Company, for their service to the Hawaiian Islands, will be ready for service within two months, according to W. P. Roth, vice-president and general manager of the Moore Shipbuilding, Oakland, Cal., at which yard these vessels are under construction.

New Tonnage Prospects.—It is announced from the International Mercantile Marine Lines at 9 Broadway, New York, that the American Line recently took over from British Registry and raised the American flag on the new 17,000 ton British liner Minnekahda which it has fitted out as a third class passenger liner for the Hamburg trade and is understood to be in the market for other tonnage.

Ferryboats, San Francisco, Cal.—The Six-Minute Ferry Company is arranging for the construction of three all-steel ferryboats, to be completed within the next five months, for operation between San Francisco and Oakland, Cal. A slip on the north side of the Ferry building has been assigned to the company, and a site for the erection of slips has been secured for the docking of their vessels across the bay.

Fleet Increase.—The Isthmian Steamship Lines of New York have ordered a 33 1/3 percent increase in the fleet which it operates in the intercoastal route touching Puget Sound and Pacific Northwest ports. The number of sailings from Seattle is to be increased from two or three a month in January, and if sufficient tonnage develops it is expected that the corporation can give Seattle a sailing each week later in the year.

Equipment for Vessel.—The S. Flory Manufacturing Company, Bangor, Pa., has a contract for four combination capstans and windlasses for an 8-yard bucket dredge being built by the Staten Island Shipbuilding Company, Port Richmond, S. I., New York, for the Victor R. Browning Company, Cleveland, Ohio. This dredge is being constructed for operation in Hell Gate and is claimed to be one of the largest of its type ever built.

Halifax Outlook Bright.—Following announcement of the launching of the 3,000-ton steamer Canadian Explorer at the plant of the Halifax Shipyards, Halifax, N. S., on December 18, statements are credited to a shipyard executive that a further expansion of their activities is to be looked for in the near future, and that should developments eventuate as anticipated, the plant will have sufficient work to carry it well into next year.

Three Vessels Ordered, Washburn, Wis.—The Anchor Shipbuilding Company has a contract for the construction of a steel ferryboat for Hudson River service. The vessel is to be equipped with full Diesel propelling machinery and is scheduled for delivery early in 1921. Additional contracts have also been secured for a steel steam lighter for Chesapeake Bay service and a steel motor cargo vessel, both of which vessels are for 1921 delivery.

Tug, New York.—The firm of Tams, Lemoin & Crane, naval architects and marine engineers, 52 Pine street, New York, has just designed a new tug, construction of which is expected to begin in the immediate future. The vessel is to be of heavy construction and designed in accordance with American Bureau's rules, to be equipped with a Scotch boiler and compound engine, electric light plant and all necessary fittings for best economy.

Pacific Coast Shipyard Busy With Repairs, Oakland, Cal.—The Moore Shipbuilding Company is repairing the steamers, Quabbin, 10,000 tons; the Quilwark, 9,400 tons; the Eastern Ocean and the Rotarian. At the Union Iron Works, San Francisco, the Associated Oil tanker William F. Herrin is receiving a new tailshaft and a propeller hub. Four vessels are undergoing repairs at the Barnes & Tibbitts yards on the east side of San Francisco Bay.

Reconstructing Freighter, San Francisco, Cal.—It is reported that the Toyo Kisen Kaisha plans to enter the oil-carrying trade from Mexico to the Orient direct. To this end the company plans to reconstruct the 17,000-ton freighter Kiyo Maru to carry fuel. It is understood, however, that no action will be taken until one of the several vessels now under construction in the Mitsubishi shipyards will be ready to replace the Kiyo on the run to Valparaiso.

New Passenger Liner, Gothenberg, Sweden.—The fastest Diesel-drive passenger liner in the world will be constructed for the Swedish-American Line in Gothenburg, Sweden, and will be placed in service some time in 1922. The vessel will be 590 feet long, with a beam of 72 feet, and will have accommodations for about 1,500 passengers, including first, second and third class. To attain a speed of 18 knots, machinery of 16,000 indicated horsepower will be installed.

Patrol Boats, San Francisco, Cal.—Commissioned to investigate shipbuilding on the Pacific Coast and to place orders for Government vessels for the Dutch East Indies up to $4,500,000, R. G. Leegraste, a naval architect of Java, arrived at San Francisco, Cal., recently. He will seek to obtain favorable terms for fast patrol boats with a speed of at least 18 knots, for use in the coast guard service in Java. The vessels will be from 900 tons up, and must be triple screw and powered with Diesel engines.

Four Freighters.—The four 20,000-ton Diesel ore carriers to be constructed for the Ore Steamship Company, a subsidiary of the Bethlehem Steel Corporation, and to cost about $5,000,000 each, will be equipped with the new Diesel engine designed by Arthur West, consulting engineer. Two of the vessels and their engines will be built in the Bethlehem corporation's San

Francisco, Cal., plant, while it is understood that the other two ore carriers will be built at the Sparrows Point yard of the Bethlehem Shipbuilding Corporation.

New Steamer for Island Service, Honolulu, T. H.—According to information received from the Interisland Navigation Company has prepared plans and specifications for the construction of a large passenger and freight steamer for service among the Hawaiian Islands. The vessel will be about 314 feet long, 41 feet beam, with a speed of 16 knots, will be modeled after the old Oceanic steamer Alameda, and have a passenger accommodation of 250 in the first and second class. The vessel, say the advices, will be built in a San Francisco yard.

Barges, Pittsburgh, Pa.—It is announced that the Carnegie Steel Company has placed an order with the American Bridge Company, Pittsburgh, Pa., for the construction of twenty-five steel barges, to be delivered next July. The vessels will be 175 feet long and 25 feet beam, with a depth of 11 feet. According to the available information these barges will be used primarily to convey coal along the Monongahela River to the Carnegie plants, but will be so constructed as to enable them to make outside trips to Southern ports with finished steel products as the need arises.

New Tankers.—Approval of the construction of four oil tankers of a total deadweight tonnage of 42,300 tons is announced by the Shipping Board, under the terms of Section 23 of the Merchant Marine Act. Three bulk oil carriers of 10,200 deadweight tons each will be built in the yards of the Bethlehem Shipbuilding Corporaton for the Pan-American Petroleum & Transport Company of New York, and the American Sugar Transit Corporation of New York will build a tanker of 6,300 deadweight tons at the yard of the Staten Island Shipbuilding Company.

New Fireboats, Philadelphia, Pa.—On approval of the Director of Public Safety and after consulting a number of construction experts, Mayor Moore has signed a contract with Cornell & Matthews to prepare plans and supervise the construction of a fireboat, and probably two fireboats. The boat will be of steel, propelled by a single screw, and will be 129 feet 9 inches long, 28 feet beam, and 12 feet 9 inches deep. Four turbine driven fire pumps with a total discharge of 10,000 gallons per minute will be installed. When completed this new vessel will be the most powerful fireboat in existence.

Japanese Company Quits New Building.—Owing to the continued shipping depression and to the fact that ten of the surrendered German ships have been allotted to Japan, it is reported that the Nippon Yusen Kaisha has abandoned its program for the construction of 500,000 tons of new ships with the exception of about 180,000 already built or ordered. Under the program the company has already acquired fourteen freighters aggregating about 100,000 tons. Six 7,000-ton freighters are being built, and will be delivered next year as well as three freighters of the 19,000-ton type, and two passenger steamers.

Shipbuilding Activities at San Pedro, Cal.—The United States steamer Pinole will go on the dry dock of the Los Angeles Shipbuilding Company for a general overhauling, and upon completion the dry dock crew will begin on three other steamers which are waiting their turn. The new dry dock will soon be completed, and following that event a large Standard Oil Tanker will be raised. The Los Angeles Shipbuilding Company has just launched the steamer Ora, which is the last of the 8,800-ton steamers to be built in the yards for the Emergency Fleet Corporation. The keel for a 11,500-ton steamer for the Shipping Board will very soon be laid.

New Plant to Construct Schooners, Portland, Ore.—Mr. G. F. Matthews, a shipbuilder, intends upon the completion of the schooner Undaunted, upon which he is now working, to remodel another Ferris type wooden steamer hull into a sailing vessel. Mr. Matthews recently purchased an extensive tract of waterfront, and the work of converting the second steamer hull into a sailing craft will be performed at the plant which he intends to erect on this site. The schooner Undaunted is being created in the Grant Smith Porter shipyard, in St. Johns, Ore., from an uncompleted hull, which was left on the ways of the yards when contracts for wooden steamers were canceled by the Emergency Fleet Corporation.

Big Shipping Deal, Vancouver, B. C.—Announcement is made of the sale of the Terminal Steam Navigation Company, to Union Steamship Company of British Columbia. The deal is the largest in shipping affairs in Vancouver this year, involving, it is understood, several hundred thousand dollars. Not only is Captain J. A. Cate's line of steamers included in the sale, but the entire park and farm property at Bowen Island also goes to the Union Steamship Company. The Union Steamship Company, through its general manager, John Barnsley, announced that it has arranged to take over the steamers and plant of the Terminal Steam Navigation Company, involving about $250,000. The company intends to build a new passenger vessel.

Ship Contracts Approved.—The Shipping Board has approved applications for the construction in accordance with the provisions of Section 23 of the Merchant Marine Act, 1920, submitted by the following companies of the vessels indicated in order that they may obtain the benefits of the provisions of the said section: Alaska Steamshp Company, 120 Broadway, New Todd Dry Dock & Construction Company, Tacoma, Wash.; Calvert Navigation Company, Baltimore, Md., steel tanker, 10,200 tons deadweight, Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md.; Sinclair Navigation Company, 120 Broadway, New York, two bulk oil tankers of 6,900 tons deadweight each, Bethlehem Shipbuilding Corporation, Harlan Plant, Wilmington, Del. Atlantic Coast Company, one schooner at Thomaston, Maine, one schooner at Rockland, Me., 2,400 tons; Frey-Flynn Company, Harrington, Me., one schooner 1,750 tons; Stockton Yard, Inc., Stockton Springs, Me., one schooner; Luckenbach Steamship Company Inc., New York, one tanker, 8,800 tons, Southwest Shipbuilding Company, East San Pedro, Cal.; Standard Oil Company of California, San Francisco, two tankers, 21,800 tons, Bethlehem Shipbuilding Corporation, Alameda plant; one tanker, 5,140 tons, Moore Shipbuilding Company, Oakland, Cal.; two tankers, 12,500 tons, Union Construction Company, Oakland, Cal.

SHIPYARDS AND DRY DOCKS

Shipyard Addition, Perth Amboy, N. J.—The Perth Amboy Dry Dock Company, foot of Broad Street, operating a shipbuilding and repair plant, plans a one-story addition to its machine shop.

Shipyards Installations, North Tonawanda, N. Y.—The Disappearing Propeller Boat Corporation, Robinson Street, is arranging for the installation of machinery at its new plant. Neill Wilson is manager.

Marine Railways, Port Neches, Tex.—A set of marine railways is to be built at the plant of Swails, Hance & Rawlings Construction Company. The plant builds all classes of vessels and also operates marine railways.

New Shipyard, Tarpon Springs, Fla.—The M. S. T. Shipbuilding Company has purchased river frontage at Tarpon Springs, on which to erect shipyards, equipped for building and launching light vessels, such as barges, etc.

Boat, Engine and Propeller Plant, Jacksonville, Fla.—L. C. Windle has established a plant known as the Disappearing Propeller Boat Company for the manufacture of boats, engines and propellers. F. E. Hewitt, Detroit, Mich., is general manager.

New Shipbuilding Plant, Saginaw, Mich.—The American Safety Navigation Company has plans under way for the construction of a new shipbuiding plant to cost more than $1,000,000, work on which is to begin at an early date. R. A. Graham is president of the company.

Shipyard Expansion, New Orleans, La.—The new plant of the Marine Iron Works, 1012 Magazine Street, will be two stories instead of one as previously announced. It will be 75 by 115 feet, and will be equipped as a machine shop and forge works, at an estimated cost of $75,000. A. J. Krail is vice-president.

Shipyard Addition, Manitowoc, Wis.—The Manitowoc Shipbuilding Company, 16th Street and Manitowoc River, is receiving bids for building a one-story 60 by 180-foot power house, of brick, reinforced concrete and steel, reinforced concrete flooring, brick foundation, on 8th Street, involving about $75,000. Private plans.

Lighter, Beaumont, Tex.—The Beaumont Shipbuilding & Dry Dock Company was awarded a contract by the Penn-Mex Fuel Company of Tampico for the construction of a 105-foot shallow draft self-propelled lighter, to be equipped with 80 horsepower Wolverine engine and to have provisions made for a derrick with two six-ton booms.

Dry Dock, Victoria, B. C.—Contract for the construction of the new Government dry dock at the Esquimault navy yard has been awarded to P. Lyall & Sons, of Montreal and Vancouver, on the firm's tender of $4,300,000, which was about $200,000 less than the Government's estimates, it is said. The dock will be 1,150 feet by 120 feet.

Shipyard Equipment, etc., Jacksonville, Fla.—The Merrill-Stevens Shipbuilding Corporation is planning to improve the shipyard of A. Bentley & Sons, which they recently acquired as a repair yard, and will make extensive additions, including equipment, involving the expenditure of about $400,000. J. E. Merrill is vice-president and general manager.

Buy Shipbuilding Plant, Portland, Ore.—With the intention of building steam schooners and barges, Carl Christiansen and Ham McCormick have bought the plant of the St. Helens Shipbuilding Company, Portland, Ore. Carl Christiansen has been superintendent of the company for a number of years. The plant has been building barges during the past few months.

To Expand Government Repair Yard, Pascagoula, Miss.—Plans are in progress for the enlargement of the Government boat yards. Major-General North, United States engineer in charge, states that this enlargement is planned for the purpose of making this yard a place for repairing all craft of the Engineering Department used in the Southern Division, including New Orleans and Pensacola, as well as Mobile.

Shipyard to Be Converted, Savannah, Ga.—The Savannah Coal & Dock Company recently organized, has acquired the former shipyard of the Foundation Company, New York, at Savannah, and is said to have perfected plans for erecting a coal-loading and handling plant, to be built at an estimated cost of $200,000, including hoisting, conveying and other machinery. It will have a capacity of 75,000 tons of coal a month, and will be augmented by a larger plant during the coming year, with a daily capacity of about 10,000 tons of coal.

New Shipbuilding Facilities at Chester, Pa.—Eight slipways at the Sun Shipbuilding Company's plant at Chester, Pa., are being extended landward so that a different form of tanker than has been constructed can be built. The new ships, of which four are for one company, will be 480 feet long and capable of carrying 12,000 tons deadweight, making them the largest built. From the bed of the Delaware River 30,000 cubic yards of material have been removed by the Sun Shipbuilding Company to provide a wet basin and dry dock costing $1,500,000, and in which the largest steamship afloat can be accommodated when the work is completed.

Yard Ready for Operation, Washburn, Wis.—The new wooden shipyard of the Anchor Shipbuilding Company was placed in operation on a contract for a vessel with 200-foot keel and 50-foot beam, designed for use as a ferry on the Hudson River at New York. The present plant consists of one way, but three additional slips are being dredged and will be completed during the winter. The Anchor Company is reported to have contracts on its books and in prospect to keep four ways busy during the 1921 season. It will build wooden ships only for the present. The organization was projected originally in the fall of 1918, but did not begin plant construction

until early in 1920. It is a $500,000 corporation organized under the laws of Wisconsin. Robert Curr is general manager.

PORT IMPROVEMENTS

Seawall, Bay St. Louis, Miss.—Specifications have been completed for building a concrete seawall.

Docks, Houston, Tex.—The Crown Oil Company will construct a dock on the city's harbor lines at Houston, Tex.

Lake Improvements, Kissimmee, Fla.—The city has issued $34,000 bonds for lake improvements. Address the Mayor.

Improve Water Front, Boynton, Fla.—The city has voted $10,000 to improve the ocean front and their electric lighting plant.

Seawall, Matagorda, Tex.—Matagorda Precinct No. 2, W. E. McNabb, commissioner, contemplates the construction of a seawall.

Municipal Wharves, Beaumont, Tex.—The city, A. B. Steinhagen, Mayor, will construct municipal wharves to cost $500,000. O. A. Seard is engineer.

Ferry Improvements, Wilmington, N. C.—The New Hanover County Commissioners issued bonds for $50,000 to be used for ferry improvements at Wilmington.

Improving Water Front, Newark, N. J.—The City Commission has authorized the issuance of $1,250,000 bonds to improve the water front and deepen Newark Bay.

Wharves, Beaumont, Tex.—The city will construct docks and wharves and extend water systems, etc., for which it has voted $2,250,000 bonds. Address the Mayor.

To Deepen Channel, Tampa, Fla.—The Atlantic Coast Line is preparing to deepen the channel at its terminal so that a heavier cargo may be loaded on vessels at that dock.

Docks, Houston, Tex.—The city will remodel its cotton docks involving an expenditure of $200,000, and is having plans and specifications prepared by the city engineer's office.

Wharf, Detroit, Mich.—The City Fire Commission let contract for building a 335-foot reinforced concrete top wharf to A. J. Dupuis & Company, 1022 Ford building; $160,889.

Wharves, Charleston, S. C.—H. F. Barkerding let a contract to the Jefferson Construction Company for building a 177-foot wharf and slip. An additional building will be erected later.

Wharf Destroyed by Fire, New Orleans, La.—The wharf of the Cuyamel Fruit Company at Desire street and the river was recently destroyed by fire, with a loss estimated at from $200,000 to $300,000.

Docks and Wharves, New Orleans, La.—Arrangements have been made by the International Harvester Company with the New Orleans Dock Board for the construction of docks and wharves to cost $250,000.

River Terminal Improvements, Minneapolis, Minn.—The city has authorized the issuance of $350,000 bonds for river terminal improvements, including docks, levee trackage, etc. F. W. Cappelen is city engineer.

Piers and Bulkheads, New York.—The Red Star Towing Line has let a contract for building several small piers and bulkheads costing about $55,000, to the Robbins-Ripley Company, 50 Church street, New York.

Water Route to Coast.—Representatives of ten states attended the meeting at Birmingham, Ala., of the Atlantic to Mississippi Canal Association, which proposes to establish a direct water route from the Middle West to the Atlantic seaboard.

Improve Docks, Vancouver, B. C.—Work has been started on the graving dock to be built at Vancouver by the Coughlin Shipbuilding Company, of which J. J. Coughlin is the head. Engineers are making preliminary borings. The cost of this improvement will be about $3,500,000.

Pier, Equipment Etc., Jacksonville, Fla.—A bond issue of $1,000,000 to construct an additional pier at municipal terminals has been recommended to the City Council by the City Commission. Two large warehouses and extensive loading equipment will be provided for in the measure recommended.

Deepening Channel, Baltimore, Md.—Among other plans for the improvement of Baltimore harbor, a movement is on foot to deepen the channel to a mean low water depth of 40 feet to the Capes, to enable the larger vessels such as the 20,000-ton ore freighters now being built at Sparrows Point, to enter the Patapsco.

Dock, Goat Island, N. J.—H. L. White, special representative for the Texas Oil Company, New York, was in Elizabeth City, N. J., recently with an engineer, making surveys and soundings at Goat Island, to find a suitable location and depth of water for a new dock which the company will build as soon as plans can be drawn.

Pier Nearing Completion, Equipment, Etc.—The Port of Tacoma, Wash., will issue $60,000 of warrants bearing 6 percent interest, in order to complete its port project to the extent of placing Pier 1 into commission. The funds will be applied to the purchase of a big crane and other equipment, as well as laying railroad tracks to the new pier.

Wharf, Houston, Tex.—The city architect has been authorized by the City Council to advertise for bids on the construction of a wharf at the Turning Basin on the Houston Ship Channel for the use of the Houston-Tampico Steamship Line, carrying freight and passengers. The project will cost about $15,000.

Dredging, Cape May, N. J.—An expenditure of $80,000 has been recommended by Major-General Lansing H. Beach, chief of the army engineers, for the dredging of the Cold Spring Inlet at Cape May, N. J. The Philadelphia & Reading Railroad is understood to contemplate building coal docks on the harbor as soon as the dredging has been completed.

Channel.—Lake Charles, La., is seeking a 30-foot channel to the sea, connecting the Gulf with the proposed route of the inter-coastal canal through Lake Charles, and making that city a deep-water port. The city recently entertained a number of engineers, inland waterway experts, United States and State Senators, and others interested, on an inspection trip over the proposed route of the channel several months ago. The cost of this project is estimated at $4,000,000.

Harbor to Be Improved, San Francisco, Cal.—The Board of State Harbor Commissioners, Ferry building, has acquired 280 acres of submerged land in Islais Creek and India Basin, and had tentative plans prepared for improving the same. Before anything further can be done, however, it will be necessary to get an appropriation from the government to dredge up to the Pier Head Line, also permission of the United States District Engineer Office to make above improvements.

Terminal Improvements, Tampa, Fla.—It is estimated that the building and equipment of docks, warehouses and coal bunkers will cost about $1,500,000. The Seaboard Dredging Company, Tampa, has the contract for dredging a slip 800 feet long and 250 feet wide as the first step in the construction of municipal terminals on the 1,400-foot channel frontage. A second slip will be dredged and equipped later on. A belt line railroad giving every road entering the city access to the docks will also be built.

Wharf, Transit Shed, Etc., San Francisco, Cal.—The State Harbor Commission, Ferry Building, San Francisco, Cal., is having plans prepared for a 100- by 1,000-foot wharf, a six-story 100- by 800-foot reinforced concrete warehouse and transit shed, double platform on water side with traveling cranes, and served with three tracks of Belt-Line Railroad, also reclaiming five acres between Third street, Channel street and Pier 46, involving 250,000 cubic yards of earth fill; about $2,500,000. F. G. White, Ferry building, is engineer.

To Force Building of Bulkheads, New York City.—Murray Hulbert, Commissioner of Docks, has asked the Sinking Fund Commission to take action compelling holders of water grants from the city who have not done so to comply with the conditions of their grants by building bulkheads and constructing streets or to forfeit the property to the city. According to Mr. Hulbert, many of the grants date back to 1863, and several generations of the owners have enjoyed the enhancement of the value of the property without fulfilling their obligations to the city. Much of the property in question is owned by the Astor estate.

Dock Improvements, Portland, Ore.—The Public Dock Commission has decided to condemn all old docks along the water front which show depreciation of 40 percent or more, and to give the owners two years' time in which to remove the structures. Pending the expiration of the two-year period owners will be permitted to make temporary repairs. The Public Dock Commission has notified the County Commissioners that the old Lower Albina ferry landing will not be restored to the county, and that if the ferry is to be resumed another slip must be provided. The land portion of the old ship will be utilized by the commission for an open dock.

To Build Ocean Terminal, Los Angeles, Cal.—Plans for the transformation of the Terminal Island frontage at Los Angeles harbor into a large ocean terminal is now under discussion. City Engineer Griffin has laid before the City Council the plans for improving this mportant part of the harbor, and they include the building of 3,200 feet of wharves on land now owned by the Salt Lake Railroad. Ultimately the city plans to build two great warehouses each 500 feet long and 100 feet wide to store freight received at these docks. The Harbor Commission has set aside $2,100,000 worth of harbor bond money to pay for the city's share of the improvement, and unless this work is pushed the city subjects itself to the danger of losing the government appropriation of $150,000 set aside several years ago for widening the channel.

Rivers and Harbors Project, Jacksonville, Fla.—Nearly $2,000,000 has been asked from Congress in the budget for improvement of the rivers and harbors for use in the Florida district. A considerable part of this amount will be spent on the development of the port of Jacksonville and dredging the St. Johns River, from Jacksonville to Palatka, at shallow places to enable schooners to go direct to Palatka to load lumber for Northern ports, thus obviating the necessity of trans-shipping this material to Jacksonville docks. The 18 miles of waterway from Jacksonville to the ocean will be dredged to not less than 30 feet in depth at any part of the channel, so as to permit vessels of large tonnage to come into the port. The engineer's report recommends that a sum of $606,000 be appropriated to carry forward this work during 1921.

American Terminal at Hamburg.—It is announced by the International Mercantile Marine Company, 9 Broadway, New York, that an up-to-date American steamship terminal will soon be constructed in Hamburg, financed by American capital, equipped with American machinery and used exclusively by American steamships. It is to be built on the Ross quay, one of the largest dock structures in Germany, and will have a total length of nearly half a mile with a depth of water alongside to accommodate the largest passenger liners now operated by the American Line from New York. The latest type electric cranes will be installed and trackage will be laid to connect the terminal with through rail lines that will carry American products to interior points in Germany, Czecho-Slovakia, Rumania and other Central-European countries.

GOVERNMENT WORK

Redredging, Texas.—The United States Engineer, Washington, D. C., rejected bids received November 24 for redredging the Galveston Channel.

Dredging.—The United States Engineer Office at Norfolk, Va., will receive bids until February 7 for the dredging of the channel in Norfolk harbor.

Harbor Development, Great Lakes, Ill.—Specification 4358, the Bureau of Yards and Docks, Navy Department, Washington, D. C., plans extensive harbor improvements at Great Lakes, Ill.

Lighthouse Tender.—Sealed proposals will be received by the Superintendent of Lighthouses, New Orleans, La., until 2 P. M., March 2, for furnishing all labor and material to completely construct, equip and deliver the 65-foot twin-screw wooden lighthouse tender Aster.

Steamer Repairs, Baltimore, Md.—The United States Bureau of Survey has awardd contracts for repairing the steamers West Cobalt for $1,190, the Waukesa for $840, and the East Indian for $2,145, to the Baltimore Dry Docks & Shipbuilding Company, and the Lake Ellerslie for $1,090 to the Spedden Shipbuilding Company.

Electric Drive Equipments, Oakland, Cal.—The Coast Guard Service has placed orders for four electric drive equipments for cutters which will be of the 3,000 horsepower synchronous motor type. The hull for the first cutter was recently laid at the yard of the Union Construction Company, Oakland, Cal., which holds the contract for the construction of all four cutters.

FOREIGN ACTIVITIES

New Jetty.—Messrs. John Lysaght, Ltd., Newport, England, have decided to construct a new jetty on the east side of the River Usk to accommodate vessels of between 2,000 and 3,000 tons; the wharf will be 300 feet long and will be constructed to deal with incoming raw material.

To Build Passenger Steamer.—It is stated that the Canadian Pacific Ocean Services, 8 Waterloo Place, Pall Mall, London, S. W., England, in-ends to build a passenger steamer for the Toronto-Niagara Line. She is to be 410 feet long by 70 feet beam, and will carry 4,000 passengers. One of her attractions will be a moving picture theater.

Shipbuilding Merger.—It is announced that the Northumberland Shipbuilding Company, Ltd., has acquired from a group of South Wales shipowners their interests in the Monmouthshire Shipbuilding Company, Ltd., which owns the National shipyard at Chepstow. In view of the new controlling interest, Lord Glanely, T. E. Morel and T. H. Mordey retire from the board of directors.

Launch First Ship.—The Newcastle Shipbuilding Company, Ltd., showed its rapid progress recently when the company launched the 3,050 gross ton steamer Zabalbide, the first vessel to be launched at its Hebburn-on-Tyne yard, and at the same time formally opened its new shipyard. Besides the Zabalbide, the company have on hand three vessels of 4,150 tons deadweight for Norwegian interests, the construction of which is well under way, as well as three tankers of 10,250 tons deadweight, for which keels were recently laid.

Resume Dredger Building.—The two shipbuilding companies at Renfrew, Scotland, Wm. Simons & Company, Ltd., and Lobnitz & Company, Ltd., whose work in normal times consists mainly of dredger building and the supply of dredging plant of all kinds, have gradually been returning to this special class of work after having completed a very large and varied volume of war-time tonnage, and it is now announced that contracts have been placed by the Indian government with both firms for the construction between them of six powerful suction dredgers for service at different ports in India.

Passenger Liners, Germany.—One of the most interesting reports from Germany received recently is that the two new steerage carriers which the Hamburg-American Line is building, and which it anticipates will be ready in the spring for the New York-Hamburg service, will be driven by Diesel engines. R. H. M. Robinson, vice-president of the United American Lines and president of the Merchant Shipbuilding Corporation, is now in Germany going over the plans of the Hamburg-American Line for its passenger steamers. The Harriman interests expect to start upon the construction of two 650-foot passenger liners some time in 1921.

Motorship Construction in Scandinavian Yards.—The Odenze Shipyard at Denmark, a recently organized shipyard, is engaged in the construction of two large steel motorships for Fred Olsen, of Christiania, in which twin-screw Burmeister & Wain Diesel engines are to be installed. The new Baltic Shipyard, at Copenhagen, which was originally laid out to construct turbine-driven ships, is now building two 6,000-ton motorships for a Copenhagen ship-owning company. The Orensundsvarvet, of Landskrona, have also turned to motorship construction and are building two large motorships for Lan Brostrom interests. One of the vessels is of 10,400 tons, and the other of 4,450 tons. The Nakskov Shipyard, which built the East Asiatic Company's motor tanker "Mexico" and the Orient Steamship Company's motor-freighter "Indien," is also concentrating on motorship construction.

Contracts Abroad

Latest reports from abroad announce the placing of numerous contracts for new ships and ship repair work, including the following:

An order for a tank steamer of 11,000 tons deadweight has been received by the Chantiers Navales Francais, Caen, France, from the Société Navale de L'Ouest. This vessel will measure 465.76 feet by 56.97 feet. The propelling machinery will consist of geared turbines developing 3,000 horsepower in giving a speed of 11 knots. The vessel is to be delivered in fourteen months.

The White Star liner Baltic is to be reconditioned at the Belfast yard of Harland & Wolff, Ltd., and the work is expected to take several months for completion. The new 16,000-ton liner now building at this yard for the same line, and which is to be equipped with geared turbines, will be named the Doric, and is expected to be launched about May. This firm has also begun the construction of a large vessel for the Atlantic Transport Company service between London and New York.

It is reported that the plant of the Dominion Shipbuilding & Repair Company, Toronto, which was closed about two months ago, is to be reopened in order to construct two 4,000-ton boats for the Canadian Government, under the supervision of the Collingwood Shipbuilding Company. The work is to be done under arrangements made with the Canadian referee of shipping and the liquidator of the Dominion Shipbuilding Company.

The Clan Line, which is owned by Cayzer Irvine & Company, Ltd., is to send to Portsmouth for alteration and re-outfitting three steamers which they have purchased from the Admiralty for conversion into merchant ships for use in tropical waters.

Reconditioning Olympic

Harland & Wolff, Ltd., of Southampton, are overhauling the White Star liner Olympic at Southampton, which will not sail again until March. The Red Star liners Lapland and Zealand are also to be overhauled at Southampton. The White Star liner Arabic, which was the ex-German liner Berlin, is being refitted at Southampton. In order to make her fit for the Mediterranean service to New York it has been necessary to construct a great amount of new accommodations.

Equipment Figures

Compilation of figures of the North Eastern Marine Engineering Company, Ltd., showing activities of that company at its Wallsend-on-Tyne and Sunderland works for the current year of 1920 show that a total of forty-two vessels of 96,572 indicated horsepower were fitted with machinery and boilers. Nine vessels were fitted with new boilers only. In their superheating department they manufactured and fitted "North Eastern" smoke superheaters to thirty-one vessels. The average indicated horsepower handled yearly for five-year average is 83,368.

MARINE SOCIETIES

AMERICA

AMERICAN SOCIETY OF NAVAL ENGINEERS
Navy Department, Washington, D. C.
President—Capt. A. J. Hepburn, U. S. N.
Secretary-Treasurer—Commander J. S. Evans, U. S. N., Bureau of Engineering, Navy Department, Washington, D. C.
Annual meeting and election, first Tuesday in October, other meetings at call of the President.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS
29 West 39th Street, New York.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS
29 West 39th Street, New York City.

UNITED STATES NAVAL INSTITUTE
Naval Academy, Annapolis, Md.
President—Rear Admiral Bradley A. Fiske, U. S. N.
Secretary and Treasurer—Commander H. K. Hewitt, U. S. N.

NATIONAL ASSOCIATION OF MASTERS, MATES AND PILOTS
National President—John H. Pruett, 423 Forty-ninth St., Brooklyn, N. Y.
National Treasurer—A. B. Devlin, 187 Randolph Ave., Jersey City, N. J.
National Secretary—M. D. Tenniswood, 308 Vine St., Camden, N. J.

LIST OF OFFICERS, AMERICAN SOCIETY OF MARINE DRAFTSMEN
President—C. E. Deiser, 6124 Nassau Road, Philadelphia, Pa.
Vice-President—E. H. Monroe, 902 Virginia Ave., Washington, D. C.
Secretary—B. G. Barnes, 970 High St., Bath, Maine.
Treasurer—J. B. Sadler, P. O. Box 987, Norfolk, Va.
Executive Committeemen—G. W. Nusbaum, Washington, D. C.; A. H. Haag, Narberth, Pa.; John Thomson, Bethlehem, Pa.

NATIONAL MARINE ENGINEERS' BENEFICIAL ASSOCIATION OFFICERS
National President—Wm. S. Brown, 356 Ellicott Square Bldg., Buffalo, N. Y.
National Secretary-Treasurer—Geo. A. Grubb, 356 Ellicott Square Bldg., Buffalo, N. Y.

CANADA

GRAND COUNCIL, N. A. OF M. E. OF CANADA
Grand President—E. Read, Rooms 10-12, Jones Building, Vancouver, B. C.
Grand Vice-President—Jeffrey Roe, Levis, P. Q.
Grand Secretary-Treasurer—Neil J. Morrison, Box 886, St. John, N. B.
Grand Conductor—E. A. House, Box 333, Midland, Ont.
Grand Door Keeper—Lemuel Winchester, 306 Fitzroy Street, Charlottetown, P. E. I.

GREAT BRITAIN

INSTITUTION OF NAVAL ARCHITECTS
5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND
39 Elmbank Crescent, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS
Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORPORATED
The Minories, Tower Hill, London.

ITALY

COLLEGIO DEGLI INGEGNERI NAVAL E MECCANICI IN ITALIA,
Via Carlo Alberto 18, Genova.

Marine Engineering

Volume XXVI MARCH, 1921 Number 3

Fig. 1.—S. S. *Hawkeye State* on Trial Trip, January 17, 1921

Passenger and Cargo Steamship Hawkeye State

The steamship Hawkeye State, the first of the sixteen 535-foot passenger and freight steamers being built for the United States Shipping Board, has been completed by the Bethlehem Shipbuilding Corporation, Ltd., at their Sparrow's Point, Md., Plant, and placed in service by the Matson Navigation Company, San Francisco, Cal., the first sailing being from Baltimore through the Panama Canal to San Francisco and Hawaii. The Sparrow's Point Plant has four more of these vessels at present under construction and nine similar ships are being built by the New York Shipbuilding Corporation, Camden, N. J., and two by the Newport News Shipbuilding and Dry Dock Company, Newport News, Va.

THE hulls of the 535-foot passenger vessels now under construction for the Shipping Board were originally laid out as troop transports, due regard being given to the possibility of ultimately converting them into first-class combined passenger and cargo steamers. In order to avoid as far as possible duplication of work in some cases where several builders had contracts for sister vessels with the United States Shipping Board Emergency Fleet Corporation, the design work was divided up and an interchange of plans effected, which resulted in a great saving to the government. This work was divided between the New York Shipbuilding Corporation and the Bethlehem Shipbuilding Corporation, Ltd., the former company supplying the structural plans and the latter the interior arrangements and architectural features.

A detailed description of the structural features of these vessels has already appeared in MARINE ENGINEERING (see page 260, April, 1920 issue), and need not be referred to beyond stating that the *Hawkeye State* is the largest passenger vessel constructed on the longitudinal system of framing. The principal dimensions and the principal data covering both hull and machinery will be found on page 190.

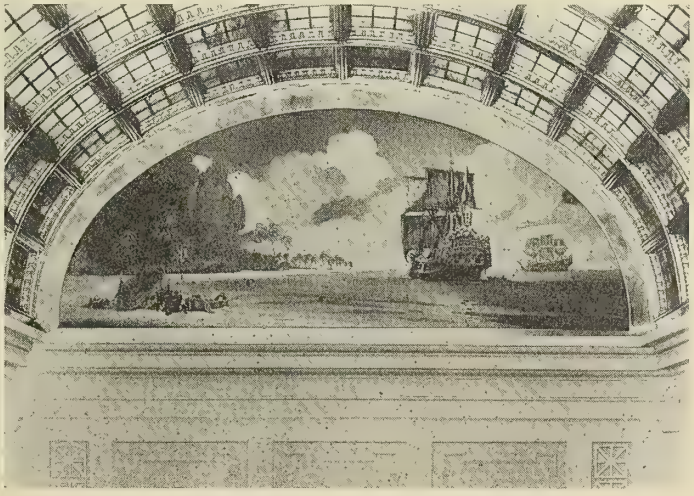


Fig. 2.—Main Stairhall Dome, Looking Forward

GENERAL ARRANGEMENT

The lower deck is complete throughout the cargo holds and the upper, shelter and shade decks are continuous for the length of the ship. There are thirteen complete watertight bulkheads extending to the shelter deck, twelve of which extend also to the shade deck.

The cargo spaces are divided into nine holds, five forward and four aft of the machinery spaces. The double bottoms are fitted for fuel oil except for the re-

serve feed tank under the engine room; 1,221 tons of oil are carried in deep tanks abreast the boiler rooms and extending to the upper deck.

The bridge deck is 228 feet long, and hatches Nos. 5 and 6 are located on this deck. Forward of No. 5 hatch is the forward boat deck house, wheel house and chart room and flying bridge. Between hatches Nos. 5 and 6 are the main bridge deck and boat deck houses. On the shade deck aft is a steel house.

Accommodations for First-Class Passengers

The accommodations for the first-class passengers are the equal of those on any ships of this type afloat, both architecturally and from the standpoint of comfort and convenience.

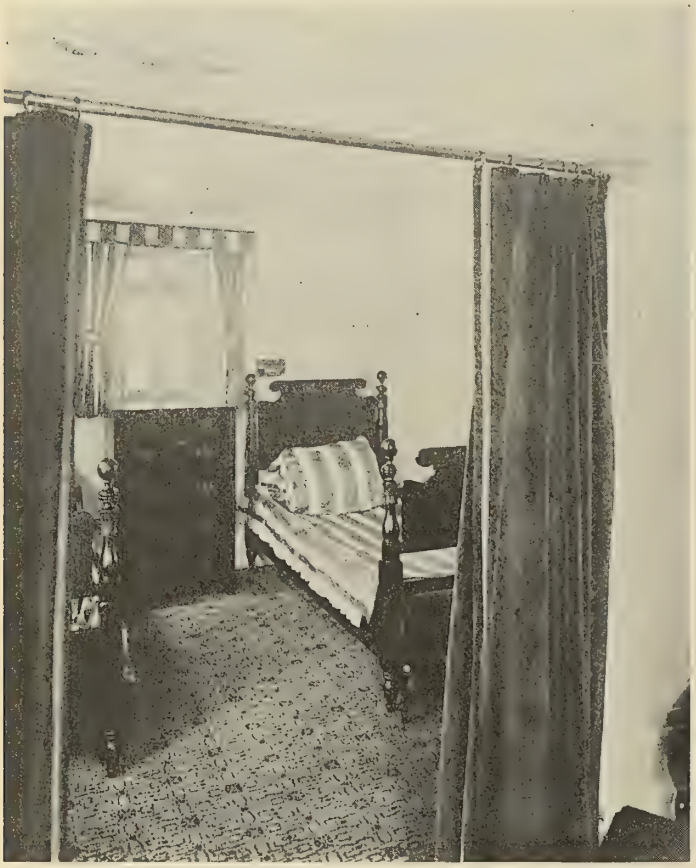


Fig. 3.—Bed Room in Private Suite, Bridge Deck

The thoroughly American character of the ship is carried out by the elimination of second-class passengers, the only difference in accommodations being in the size and location of staterooms and the private baths, and not in the architecture, or by any divisions of the public spaces.

The nationality of the ship is further emphasized by the style of architecture, which is American Colonial throughout. The first-class quarters are finished in light colorings and hangings, well adapted for the tropical route on which the ship will trade.

The passengers enter the ship through side ports into the lobby forward of the dining saloon on the shelter deck. This lobby and all shelter and upper deck lobbies and passages are finished in cream white enamel, the cream of the woodwork being very slightly lighter in shade than the vehisote panels. The floors of these spaces are covered with bluish gray interlocking rubber tiling.

Forward of the above lobby are fifteen staterooms, only two being inside rooms. These, in common with all first-class staterooms on the ship, have the same cream colored woodwork as the passages, but the paneling is stippled light sky blue with touches of gold leaf on the borders and moldings. The doors, tables, settee berths, bureaus and handrails are mahogany, and the beds are metal, one of them folding out of sight.

The rooms in this part of the ship are not provided with private baths, but each room has a lavatory with running hot and cold water. The floors of all staterooms are covered with Wilton rugs. In this space, on the starboard side next to the entrance lobby, is an up-to-the-minute barber shop.

Main Dining Saloon

Aft of the lobby already described is the main dining saloon, furnished with circular mahogany tables seating six persons each in mahogany armchairs. This room is finished

Fig. 4.—Stairhall from Shelter Deck, Entrance Lobby

in pale green shades, with dark green curtains, hangings and a liberal amount of gold leaf for finish over head. The floor is interlocking rubber tile in white and red. In the center is a semi-cylindrical gilded dome with small art glass panels lighted from above. At the ends of this dome are two mural paintings depicting ancient and modern fleets. Large mirrored mahogany buffets are aft of the dome.

Double doors lead from the aft port side of the dining saloon to the first-class pantry and aft on the starboard side are five more first-class staterooms. These rooms have private baths and are among the best on the ship. If desired, these rooms could be given over to one party, as they have their private stairway to the shade deck and could be closed off from the quarters aft.

Aft of the engine hatch a large stairway from the shade deck leads to the forty-six after shelter deck staterooms. These rooms will be among the least expensive on the ship. However, each room has an upholstered settee berth in addition to the two regular berths; each room also has a closet and running water.

A double stairway leads from the shelter deck lobby at

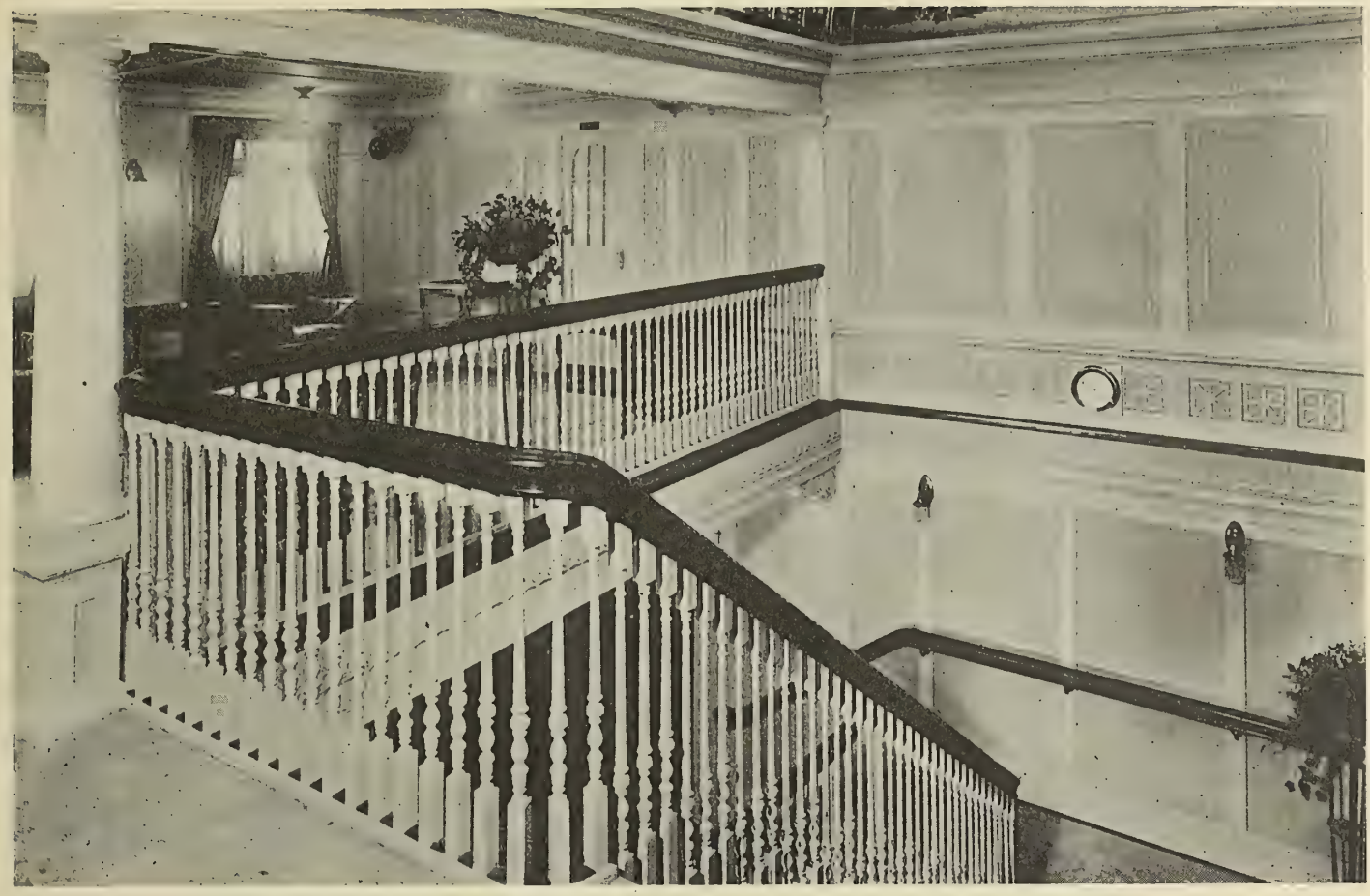


Fig. 5.—Lobby and Main Stairway, Boat Deck, Looking Forward

Fig. 6.—Main Dining Saloon, Shelter Deck, Looking to Port

Fig. 7.—Tea Room, Boat Deck, Starboard Side, Looking Forward

Fig. 8.—Writing Room, Boat Deck, Looking Aft

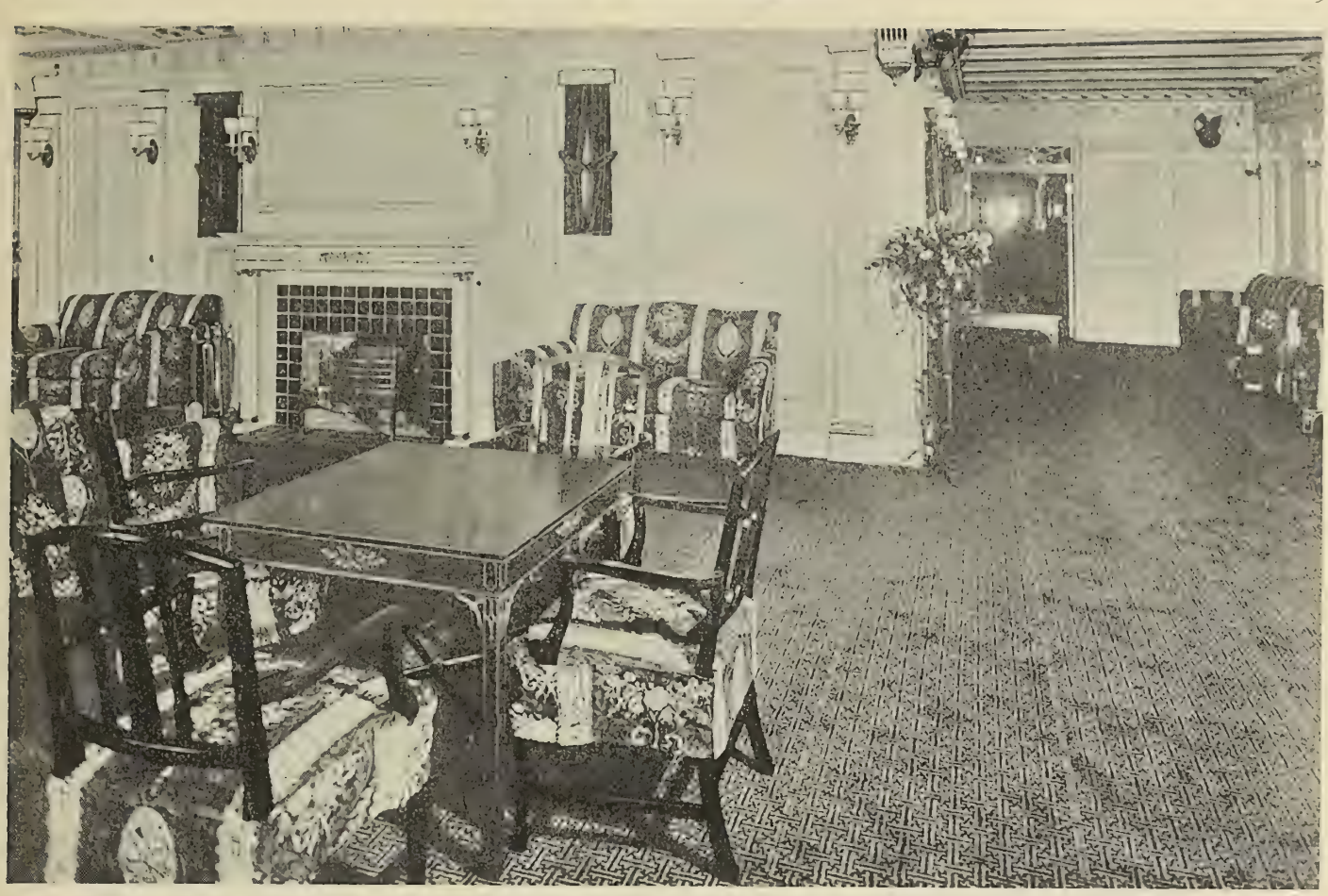


Fig. 9.—Social Hall on Bridge Deck, Port Side, Looking Aft

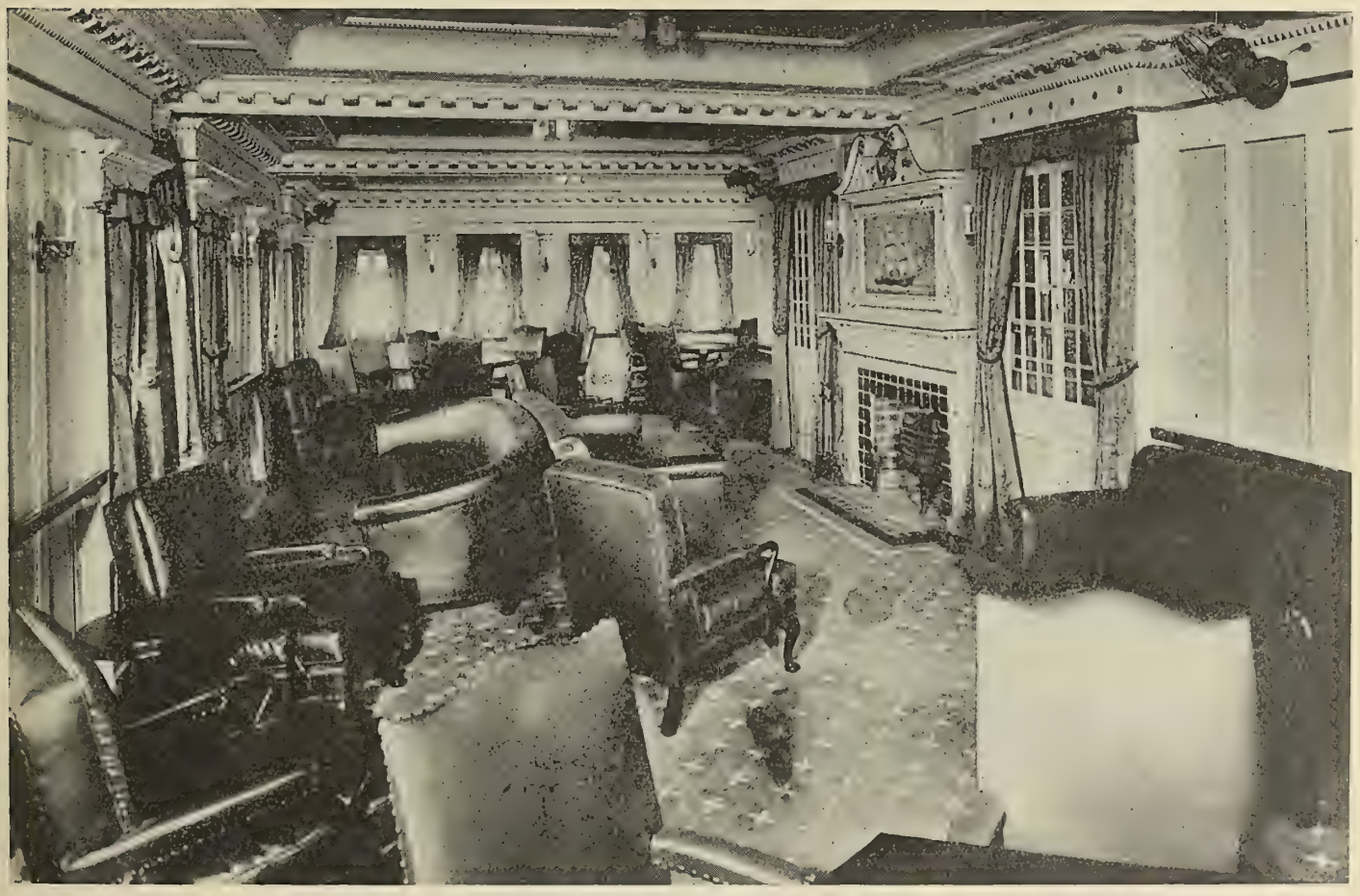


Fig. 10.—Smoking Room, Bridge Deck, Looking to Port

Passenger and Cargo Steamship Hawkeye State

General Information

Service: San Francisco and Hawaii, passenger and freight.

Builder: Sparrow's Point (Md.) Plant, Bethlehem Shipbuilding Corporation, Ltd.

Owner: United States Shipping Board. Allocated to Matson Navigation Company, San Francisco, Cal.

Characteristics

Length, overall.....535 feet
Length on waterline.....534 feet
Beam, molded.....72 feet
Depth to "A" or shade deck, molded..50 feet
Depth to "B" or shelter deck, molded 41 feet
Draft, summer freeboard..30 feet 6¼ inches
Block coefficient at 30 feet 6¼-inch draft 0.633
Midship coefficient 0.99
Longitudinal coefficient 0.642
Speed, on trial, knots.....19
Cruising radius, at 16 knots, nautical miles 13,500
Framing .....Longitudinal
Class ....A-1 American Bureau of Shipping

Tonnages

(In tons of 2,240 pounds)

*Weight of hull 8,340
**Weight of propelling machinery....1,040
Deadweight capacity, at 30 feet 6¼-inch draft, approximately 11,900
Displacement, at 30 feet 6¼-inch draft.. 21,300
Tons per inch immersion.....68.6

(In tons of 100 cubic feet)

Gross register.....14,124
Net register 8,383

* Weight of hull includes hull proper, hull fittings, equipment and outfit.
** Weight of propelling machinery includes engines, boilers (wet), shafting, propellers, and machinery space auxiliaries.

Canal Ratings

(In tons of 100 cubic feet)

	Gross	Net
Suez	14,606	10,077
Panama	15,234	10,434

Complement

Deck department	42
Engine department	45
Stewards' department	108
Miscellaneous	8
Total crew	203
First-class passengers	259
Steerage passengers	302
Total passengers	561.
Miscellaneous	10
Total complement	774

Handling Equipment

	No.	Type	Capacity	Length
Masts	2	Topmasts		
King posts	10			
Booms	32	wood	6 tons	Outboard, 53'
				Inboard, 46'
	1	steel	30 tons	58'

Discharging capacity.....500 tons per hour

Deck Machinery

Steering gear.....Screw gear type, 16" by 12".
Windlass (1).....Triple spur geared, 13" by 13".
Steam gypsies (2).....10" by 10".
Winch heads for warping ship (2).
Winches (8).....Compound geared
Winches (24) ....Single geared, 9" by 12".

Life Saving Equipment

Lifeboats	No.	Type	Length
Lifeboats	15	Double decked	26'
	2	motorboats	24'
	2	work boats	18'

Propelling Machinery

Boilers

Number 8
Type .....Yarrow watertube
Length .....12 feet 10 inches
Width .....16 feet 6 inches
Fuel .....Oil
Number of Burners per boiler.....5
Draft .....Forced, closed stokehold system
Total heating surface, square feet....40,000
Total furnace volume, cubic feet.....4,896
Ratio of furnace volume to heating surface 0.1224
Superheat, degrees F. 75
Working pressure, pounds per square inch 265
Normal fuel consumption:
Per day, tons 115
Per horsepower hour, pounds....0.9
Normal steam production:
Per hour per pound of fuel....14.25
Total per hour 153,000

Engines

Number 2
Type .....High and low pressure Curtis multi-stage impulse turbines.
Size .....Each unit, 6,000 horsepower
Shaft horsepower, total.....12,000
Shaft horsepower, maximum.....13,200

Propellers

Number 2
Type .....Three-bladed, solid, manganese bronze.
Weight .....23,000 pounds
Diameter ..... 16' 6"
Pitch ..... 17'
R. P. M. 125
Projected area .....72.6 square feet
Developed area .....85 square feet

Auxiliary Machinery

Refrigerating Machinery

2 15-ton York CO_2 machines.
1 ice machine, 1,000 pounds per day.

Machinery Space

2 main condensers, 7,200 square feet cooling surface each.
1 auxiliary condenser, 1,500 square feet cooling surface.
2 evaporators, Griscom-Russell, 35 tons each.
2 distillers, Griscom-Russell, 3,000 gallons per day each.
1 charcoal filter, Griscom-Russell, 3,000 gallons per day, each.
1 aerator
1 feed water heater, Row & Davis.
1 feed and filter tank.....1,000 gals.
1 supplementary feed and filter tank .....240 gals.

Pumps (supplied by Dean Bros.):
2 main feed, v. s., 18" x 12" x 24"
1 aux. feed, v. s., 10" x 7" x 24"
1 ballast, h. d., 10" x 12" x 12"
1 fire, bilge and general service, h. d., 12" x 8½" x 12"
1 sanitary, v. d., 8" x 8" x 12"
1 engine room and 1 fire room bilge, v. s., 5½" x 7" x 12"
1 fresh water, 1 evaporator feed, 1 hot water return, h. d., 7" x 6" x 10"
1 drinking water, h. d., 4" x 3¾" x 5"
1 aux. air, v. s., 10" x 18" x 12"
1 oil transfer, v. s., 8" x 8" x 12"
4 lubricating oil and 2 cooler, v. s., 8" x 10" x 14"
1 ice machine condenser circulating and 2 brine circulating, h. d., 6" x 6" x 6"
1 centrifugal aux. circulating, 10" suction and discharge driven by 7" x 6" reciprocating engine
2 main turbine-driven, centrifugal, Worthington double suction circulating.
4 Radojet air pumps
4 10 H. P. turbo-driven condensate pumps

Electric Equipment

Generators....Four 50-K. W. General Electric, driven by Terry turbines
One 5-K. W. emergency set, driven by gasoline engine

Capacities

Cargo Space

Compartment	Cubic Feet
Hold No. 1	10,505
Lower 'tween decks No. 1	6,699
Upper 'tween decks No. 1	8,135
Shelter 'tween decks No. 1	13,303
Hold No. 2	21,553
Lower 'tween decks No. 2	11,869
Upper 'tween decks No. 2	12,707
Trunked hatch No. 2	5,170
Hold No. 3	31,160
Lower 'tween decks No. 3	16,670
Upper 'tween decks No. 3	16,929
Trunked hatch No. 3	6,460
Hold No. 4	38,345
Lower 'tween decks No. 4	20,585
Trunked hatch No. 4	11,300
Hold No. 5	44,120
Trunked hatch No. 5	23,275
Hold No. 6	35,889
Lower 'tween decks No. 6	22,593
Trunked hatch No. 6	11,300
Hold No. 7	20,546
Lower 'tween decks No. 7	21,801
Upper 'tween decks No. 7	21,251
Trunked hatch No. 7	6,175
Hold No. 8	11,163
Lower 'tween decks No. 8	18,752
Upper 'tween decks No. 8	19,518
Trunked hatch No. 8	6,175
Hold No. 9	6,380
Lower 'tween decks No. 9	13,073
Total	513,401

Refrigerated Space

Compartment	Cubic Feet
Meat cargo, port	4,032
ship's consumption	6,021
Butter and eggs	665
Fish	1,140
Poultry	980
Vegetables	1,405
Total	14,243

Bunkers

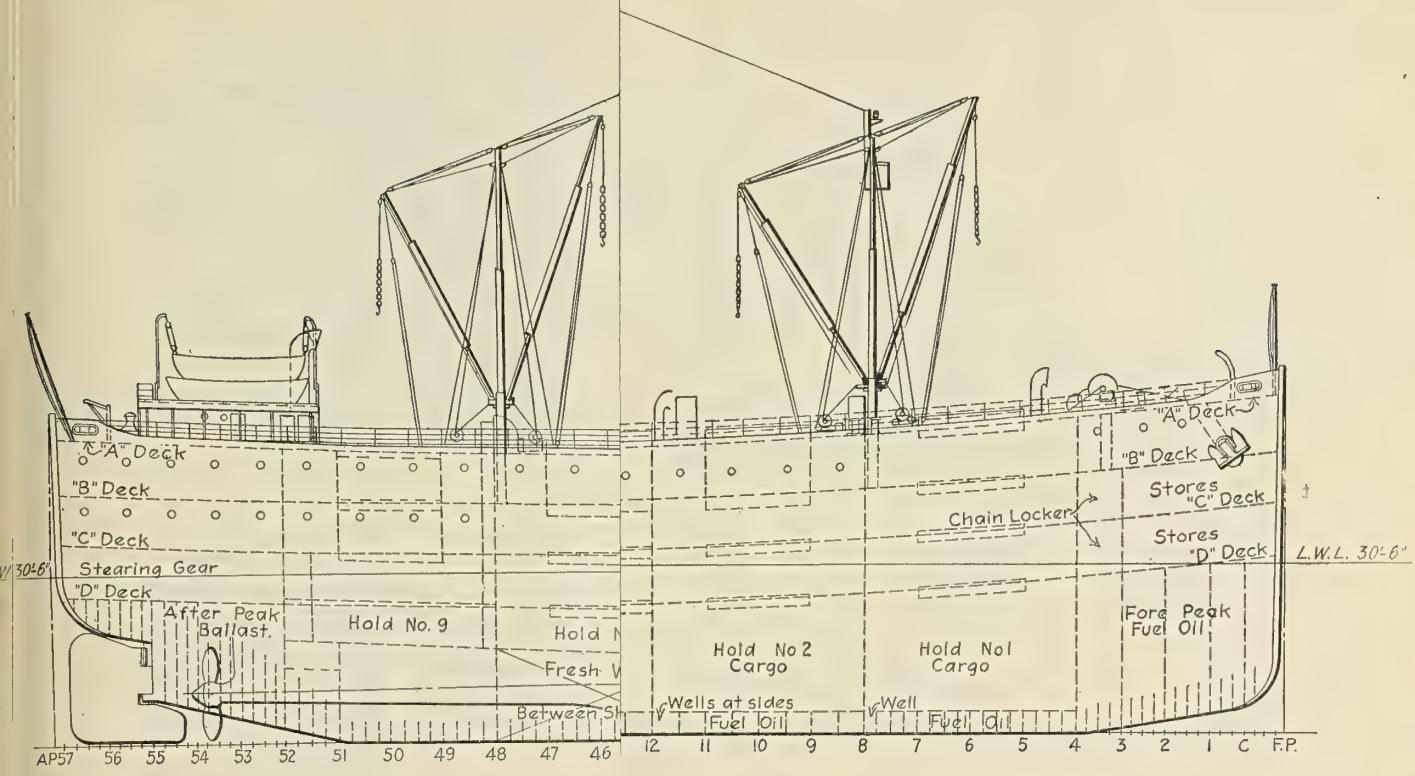
Compartment	Cu. Ft.	Tons
Fore peak tank	5,555	138.9
No. 1 Dbl. bottom P. & S.	1,244	31.1
No. 2 " " "	3,288	82.2
No. 3 " " "	5,791	144.8
No. 4 " " "	7,649	191.2
No. 5 " " "	8,801	220.0
No. 6 " " "	10,038	250.9
No. 8 " " "	9,956	248.9
No. 9 " " "	5,789	144.7
No. 10 " " "	2,534	63.5
No. 24-28 deep tank	25,090	627.2
No. 28-32 " "	25,264	631.6
	110,999	2775.0

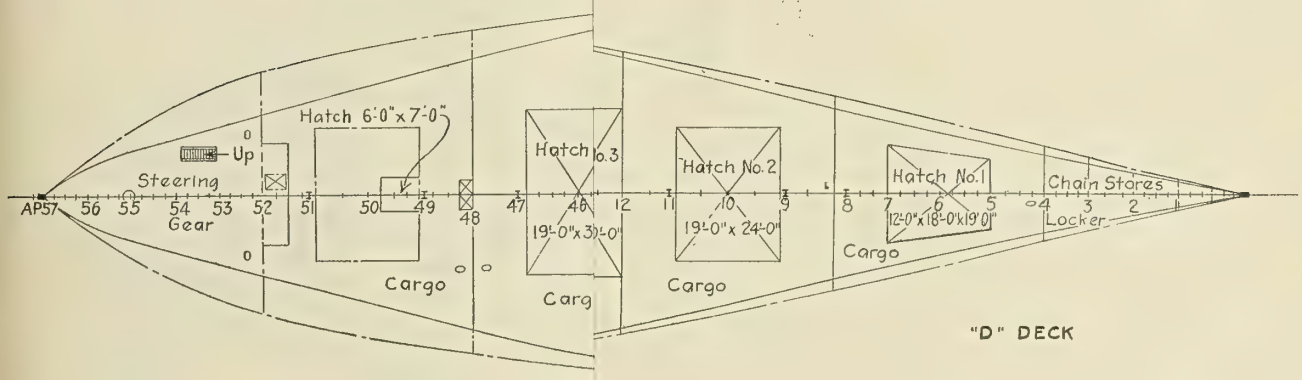
*40 cubic feet per ton; 42 gallons per barrel.

Tanks

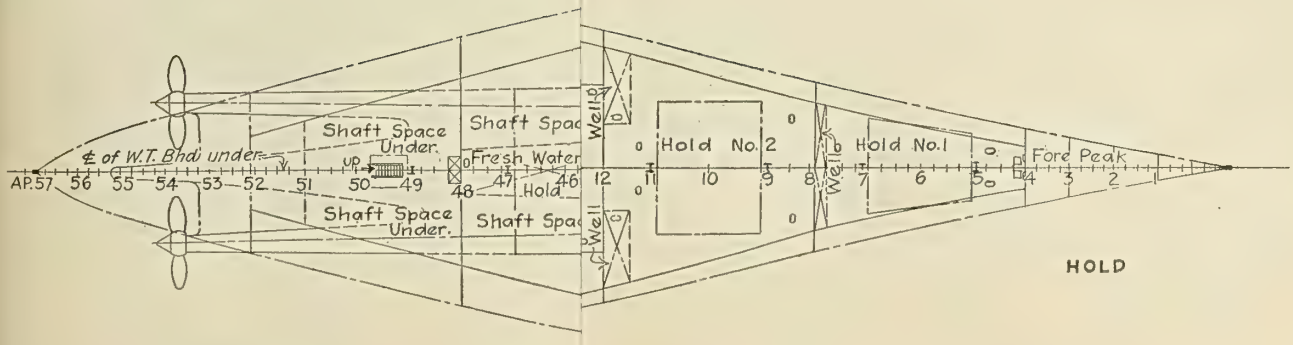
Compartment	Cu. Ft.	Tons F. W.	Tons S. W.
Fore peak tank	5,555		158.7
No. 1 Dbl. bottom P. & S.	1,244		35.5
No. 2 " " "	3,288		93.9
No. 3 " " "	5,791		165.5
No. 4 " " "	7,649		218.5
No. 5 " " "	8,801		251.4
No. 6 " " "	10,038		286.8
No. 8 " " "	9,956		284.5
No. 9 " " "	5,789		165.4
No. 10 " " "	2,534		72.4
After peak tank	5,642		161.2
No. 40 to 44 F. W. tank		234.1	
No. 44 to 48 " "		143.9	
No. 33 to 36 Deep "		273.2	
Gravity tanks		6.3	6.7
Total		657.5	1,900.5

PASTATE





"D" DECK



HOLD

PASSENGER AND CARGO STEAMSHIP HAWKEYE STATE

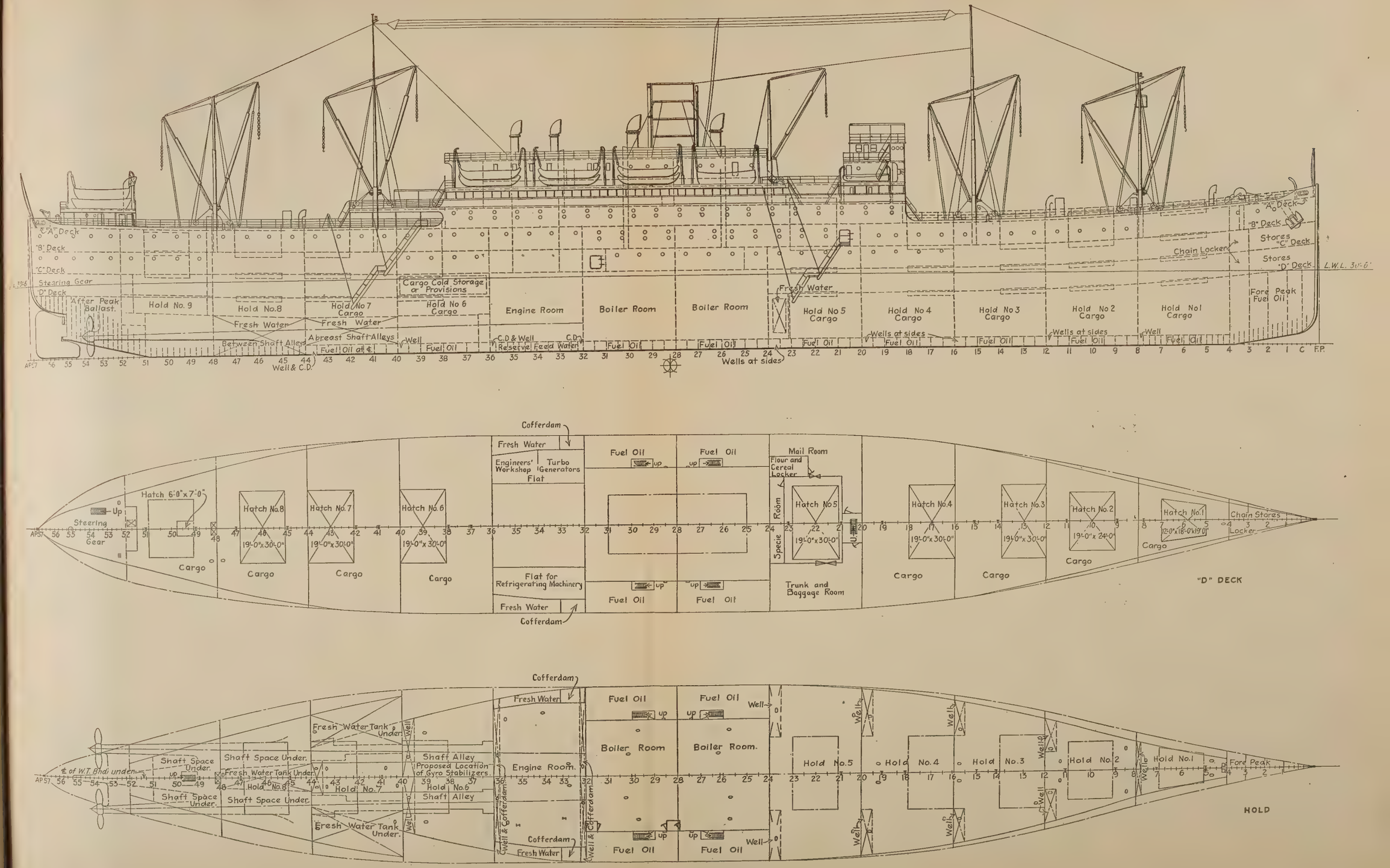
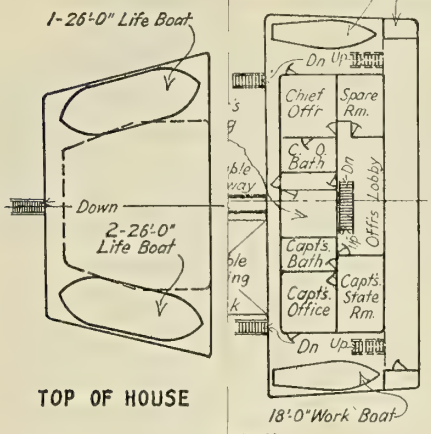


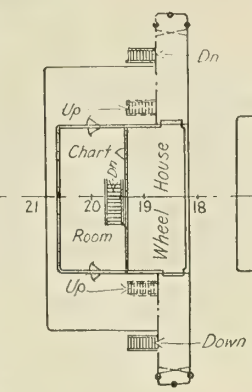
Fig. 11.—Profile and Deck Plans

STATE

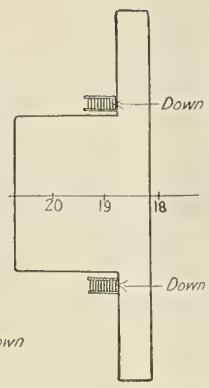


TOP OF HOUSE

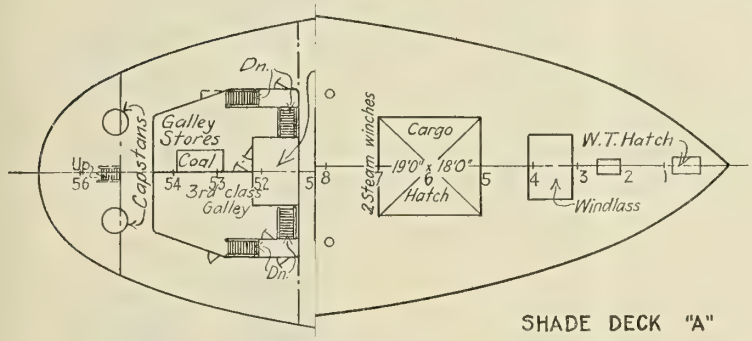
DECK



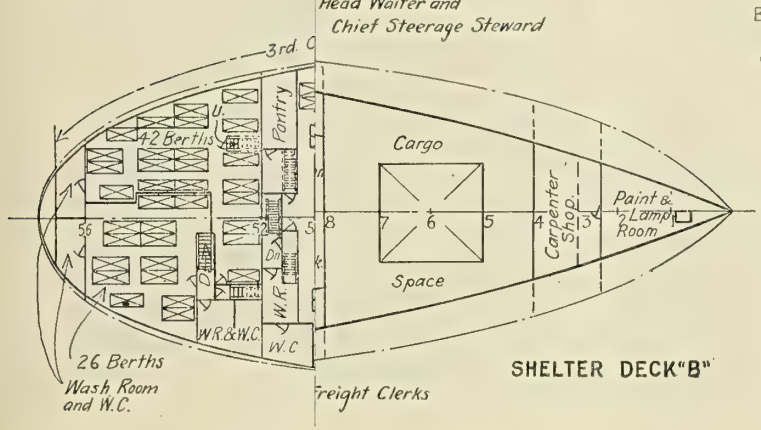
HOUSE TOP



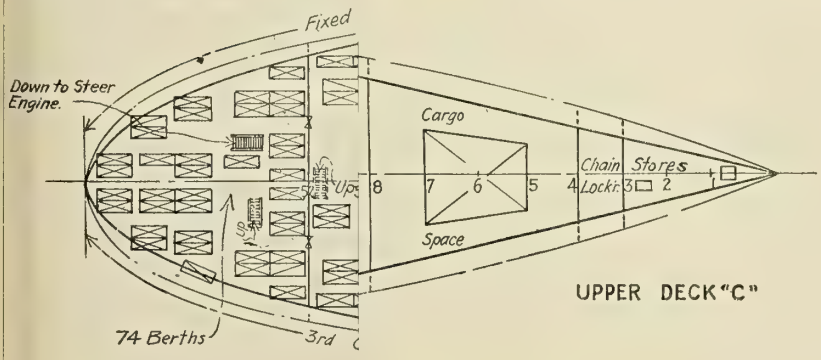
FLYING BRIDGE



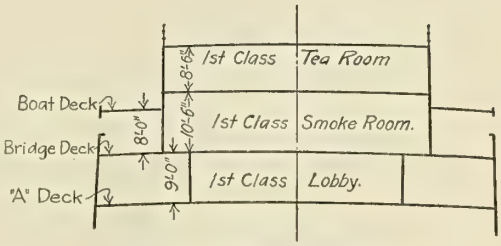
SHADE DECK "A"



SHELTER DECK "B"



UPPER DECK "C"



SECTION THRU PUBLIC ROOMS AT FR. 36

Dimensions:-

Length O.A.	535'-0"
Breadth Mld	72'-0"
Depth Shade Dk.	50'-0"

Passenger List:-

1st Class		259
3rd Class		300
	Total	559
Maids		4
	Total	563

Crew List:

Spare Room		10
Deck Dept		42
Eng Dept		45
Stewards Dept		108
Miscellaneous Dept.		4
	Total	209
	Total	772

Boat Dk { 12 – 26'-0" Life Boats @ 50 Pass. Each 600
2 – 24'-0" Motor Life Boats @ 17 Pass Each 34
Aft Dk House – 3 – 26'-0" Life Boats @ 50 Pass. Each 150
Total 784

Note:-
Doors shown in B'hds No's 20, 24, 28, 32, 36 & 54 above "C" Dk to be 26" x 60" Hor Sliding W.T. Doors, and to be operated from "B" Deck.
Doors shown in B'hds No's 12, 16, 20, 28, 32, 36, 40 & 44 above "B" Dk to be 26" x 60" hinged W.T. Doors.

PASSENGER AND CARGO STEAMSHIP HAWKEYE STATE

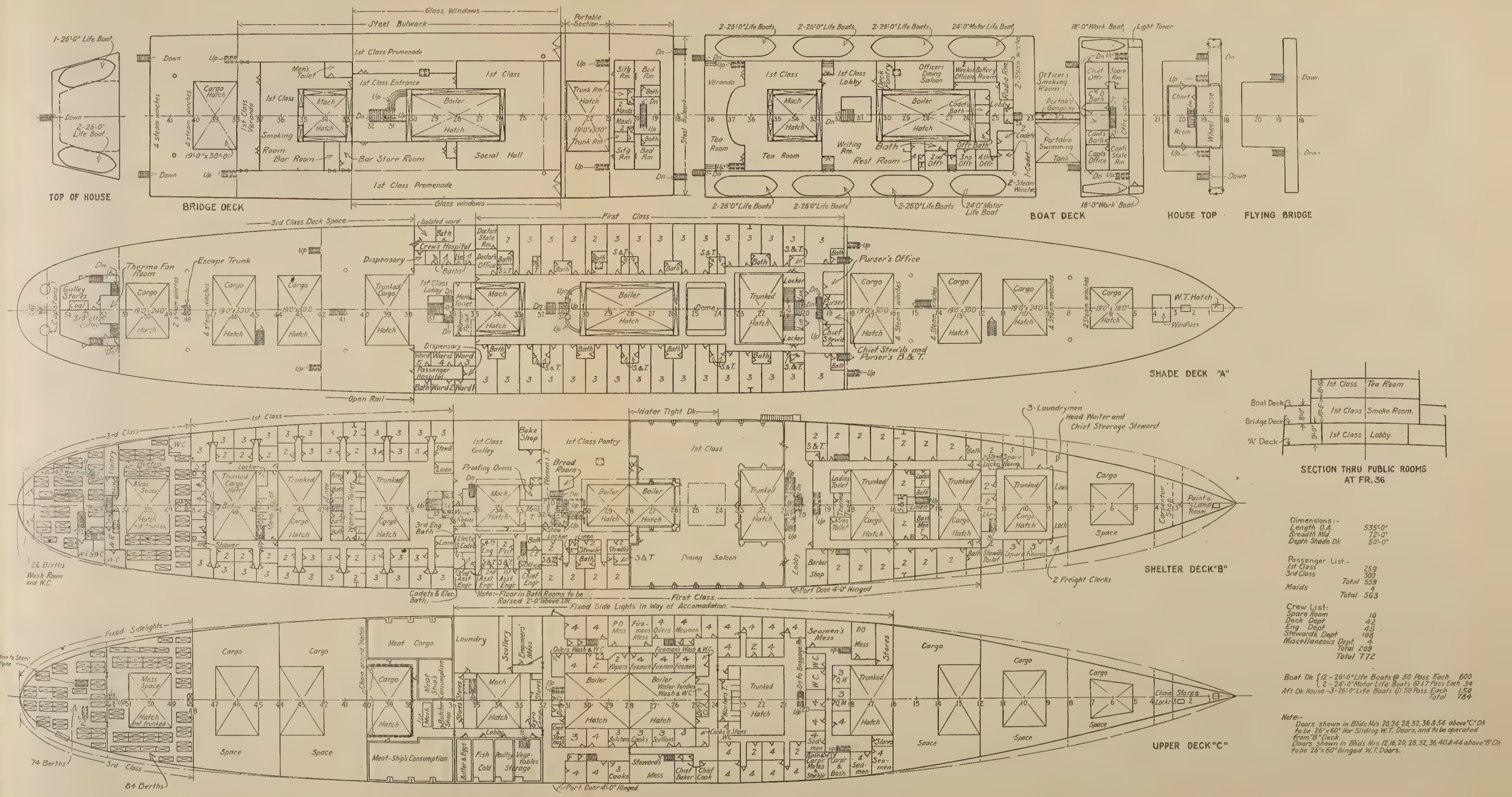


Fig. 12.—Deck Plans

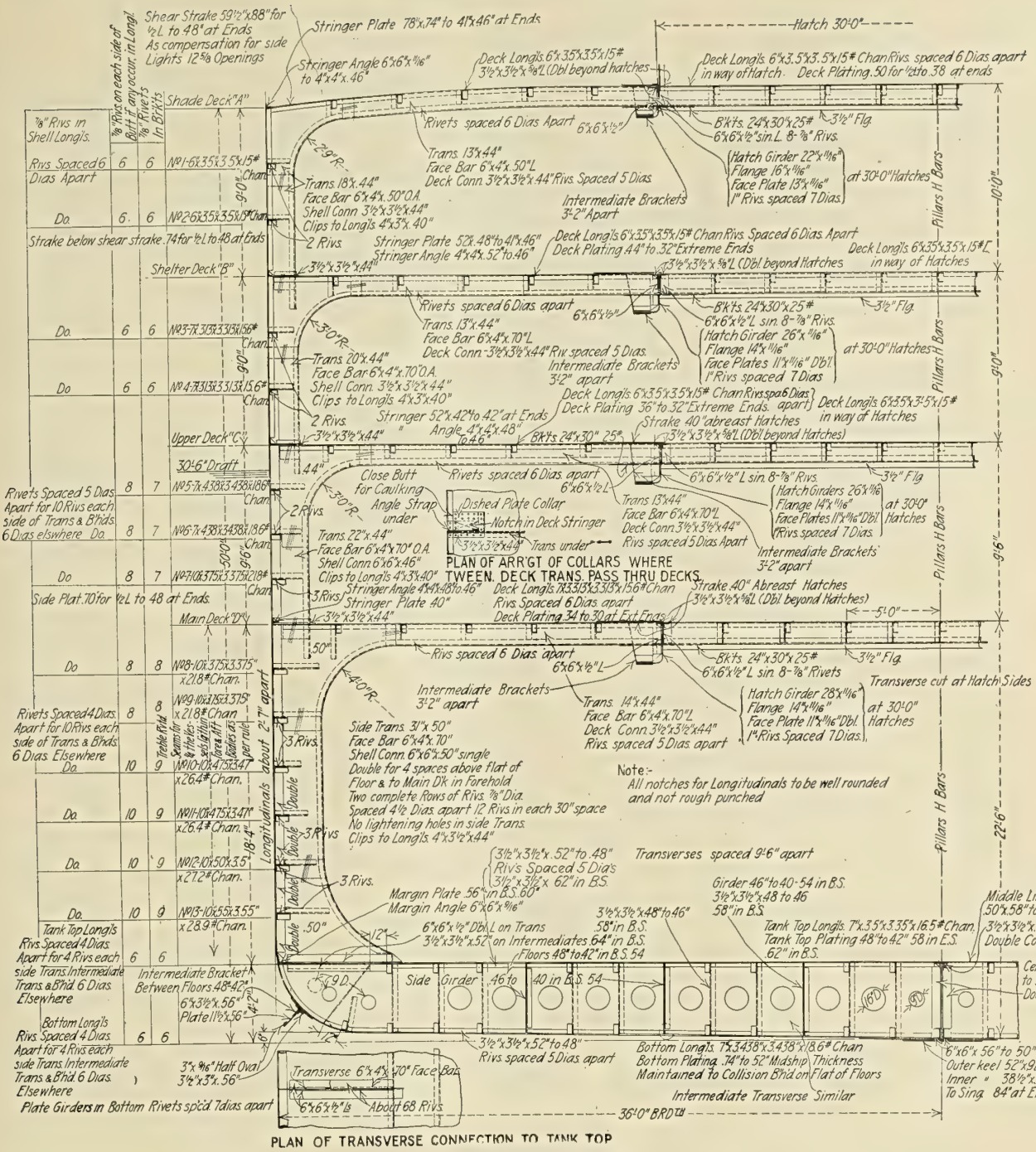


Fig. 13.—Midship Section

which the ship was entered to the forward end of the shade deck house. This stairway is ornamented in gilt and decorated by two sea paintings. At the center is a gilt framed mirror surmounted by a fine Chelsea clock.

Staterooms de Luxe

The twenty-nine staterooms on the shade deck are among the best on the ship. Each has a private bath, in most cases having both tub and shower. The staterooms side of the mahogany bathroom doors have full length mirrors. Two airports in each room provide natural light. The furniture consists of two beds (one folding in behind a panel), a mahogany table, two mahognay bureaus, an upholstered settee berth and a wicker chair. The forward two of these rooms are exceptionally commodious.

Ten passengers can be accommodated in the hospital on the starboard side at the after end of this house.

There are three stairways from the shade deck up to the bridge deck. The forward one leads to the forward bridge deck house, which is given over to two private suites each consisting of sitting room, bed room, bath, maid's room and trunk room. The prevailing cream color is retained in these suites, brightened by window hangings and portieres of old rose.

Public Rooms on the Bridge Deck

The main stairway from the shade deck is between the engine and boiler casings and leads up to the bridge deck entrance hall, and beyond to the boat deck lobby and writing room. The arrangement of the bridge deck entrance forms an alcove on the starboard side and on the port side leads forward to the social hall and aft to the smoking room.

The social hall is unsurpassed by any room on the ship, the cream finish being retained, properly relieved by gold leaf, and old rose and gilt window curtains of velvet. The chairs, sofas, tables, Brunswick talking machine and Steinway grand piano are all of special design in black lacquer.

A fireplace and Wilton rug add to the warmth of this room.

The smoking room is entered on the port side, and tapestry hangings and red and white rubber tile are combined with the prevailing cream color. The furniture is of mahogany upholstered in leather. The doors and windows at the after end open on to a sheltered veranda, while opposite these a fireplace is flanked by two well-stocked bookcases. Over the fireplace is a painting of a full rigged ship and another Chelsea clock. The bar room opens from the starboard side of this room.

The main stairway continues on up to the boat deck under another gilded dome. The natural light possible for this dome shows off with fine effect the mural paintings at each end, one depicting the New York skyline from the Jersey side, the other being a tropical island scene. The lobby at the head of this stairway forms part of the writing room on the starboard side. The chairs and tables are of mahogany, of special design. A well appointed stenographer's desk and built-in book case complete the furnishings of this room. Directly forward of the writing room is a ladies' rest room.

The Tea Room an Attractive Feature

Double doors from both writing room and lobby lead aft into the tea room. The coloring of this room is a departure from the familiar cream, latticing of dark yellow being worked on a putty gray background. The furniture is painted and decorated to match the architecture of the room and English ivy clings to the latticing. Large sofas and a fireplace are attractive features of this room.

The tea room is served from a pantry at the forward end of the boat deck lobby, and looks out at the after end on to another sheltered veranda, which is reached by double doors port and starboard. The architectural features were originated by the staff of the builder's, The Bethlehem Shipbuilding Corporation, Ltd. The interior painting, decorating, carpets and rugs, hangings and specially designed furniture for the public rooms were furnished by Irving & Casson—A. H. Davenport Company, Boston, Mass. Mr. Carrol Bill, artist of this firm, is responsible for the mural paintings.

In addition to the verandas opening from the smoking and tea rooms, which have been mentioned, exceptionally wide promenades flank the bridge deck protected abreast the social and entrance halls by sliding windows of the Laycock type. The boat deck house top aft of the engine hatch provides the largest unobstructed area on the ship and in good weather should prove extremely popular. Between the two bridge deck houses a canvas swimming pool can be erected for the enjoyment of passengers in suitable weather. Shuffle boards, deck quoits and a punching bag give the passengers additional opportunity for outdoor exercise and recreation, and an electric player piano on the bridge deck will furnish dance music.

A companionway from the shelter deck entrance lobby leads down to the first-class passengers' baggage room in No. 5 hold on the lower deck, where are also located the mail and specie rooms and a flour and cereal locker.

Third-Class Quarters

Accommodations for 300 steerage passengers are provided on the shelter and upper decks aft of bulkhead No. 48. These accommodations are divided into four compartments, with a pantry and all toilet and wash spaces on the shelter deck.

All pipe berths and mess tables are portable so that these spaces can be readily converted into cargo holds. This is being done by the Matson Navigation Company on the present cruise.

The entrance to these quarters is from the after shade deck house, which contains the third-class galley and a large room for galley stores.

Officers' and Crew's Quarters

All crew's quarters are fitted with 1⅛-inch tongued and grooved cypress partitions and galvanized pipe berths. The seamen and petty officers are quartered on the upper deck around the trunked hatch to No. 4 hold. Waiters, musicians, etc., are accommodated on this deck over No. 5 hold.

Abreast the boiler hatches the engine and fireroom crew are located on the port side and the stewards' department on the starboard side. The different divisions of the crew have, each adjacent to their quarters, six messrooms on the upper deck. Each messroom has a steam table, tea and coffee urns and an ice chest.

On the shelter deck forward of the first-class quarters, are staterooms for eleven more of the crew and three spare rooms. On this deck, in the first-class quarters, are two inside staterooms for the stewardesses, and abreast the machinery hatch on the starboard side are well appointed quarters for the engineer officers. The chief engineer's office and stateroom are panelled in quartered white oak.

The purser and chief steward are quartered at the forward end of the shade deck house and at the after end of this house on the port side is the doctor and crew's hospital.

The captain and chief officer are quartered in the forward boat deck house, which also contains an officers' lobby and officers' smoking room. These quarters are panelled in quartered white oak. A portable gangway over No. 5 hatch leads from these quarters aft to the forward end of the boat deck house, where are located the remaining officers' quarters, the radio and battery rooms and the officers' mess, which is also panelled in quartered white oak. The latter room accommodates twenty at two tables with swivel oak chairs and, although having dumbwaiter service to first-class pantry, has its own sink, steam table and coffee urns.

Galley and Pantry Equipment

The galley and pantry equipment on this ship are worthy of more than passing comment. The first-class pantry, just aft of the dining saloon on the port side, is equipped with an electric dishwashing machine, automatic egg boiler, electric roll warmer and toaster, 10-foot steam table and a smaller table. The wine room and cold service room open into this pantry. A dumb waiter serves the officers' mess on the boat deck and the mess rooms for engineers and crew on the deck below.

Aft of the pantry is the first-class galley and the bake shop with a dumbwaiter and companion hatch to reach the scullery, butcher shop, messrooms, storerooms and refrigerator spaces below. The oil-burning range has four fires and four ovens. There are two electric bake ovens, a steam proofing oven, electric broiler, steam kettle, stock pot, electric vegetable parer and electric cake mixer.

The third-class galley, in the aft shade deck house, has a coal-burning range, with large coal box in the galley storeroom on the port side of this house.

Cargo Handling Equipment

The detailed description which has been given of the elaborate accommodations for passengers on this vessel should not allow the fact to be lost sight of that this ship is primarily a cargo carrying vessel, having a capacity of about 8,000 tons of cargo in the holds. The facilities providing for expeditious loading and unloading of this cargo are unusually complete, the absurdity of combining the speed of this ship with long periods of lost time for cargo handling being kept in mind.

Heating and Ventilation

Details of the cargo booms, winches, windlass, steering gear and other deck machinery, including the life saving equipment, will be found on page 190.

Throughout the first-class quarters, heating and ventilating

are accomplished to a great extent by a combined thermotank system, using Sturtevant blowers and Schutte-Koerting thermotanks. The same system is used for the third-class quarters.

The capacity of this system is designed to heat all public rooms to 70 degrees F., and is also capable of delivering cold air when desired. In the staterooms, this system is to heat to 50 degrees F., and electric heaters concealed behind grills may be used to make up the deficiency when required.

First-class passages, public toilet spaces and all crew spaces are heated by steam radiators. Ample natural ventilation is supplied for the cargo holds by means of cowl vents.

In addition to the usual natural ventilation for the engine room, two 2,400 cubic feet per minute blowers supply air to the engineers' workshop, motor generator room, and refrigerating machinery room, which are located on flats under the upper deck.

The hot fresh water system is so arranged as to keep the water constantly circulating through the pipes, a small automatically controlled pump in the engine room returning the water to the hot fresh water tank in the boiler casing. Hot fresh water is supplied to first-class passengers' showers and lavatories and officers' lavatories. Hot salt water is supplied to first-class passengers' bath tubs, officers' and crew's showers, and slop sinks. Cold fresh water is supplied to first-class passenger showers and lavatories, officers' lavatories and sinks in third-class quarters. Cold salt water is supplied to first-class passengers' tubs, officers' and crew's showers, crew and third-class lavatories.

Ice water is piped to the crew's and officers' mess rooms and to six white metal drinking fountains in the first-class lobbies.

The plumbing throughout is of first quality and many of the fixtures are of special design, all being supplied by A. B. Sands and Son Company, New York.

Refrigerating Plant

The refrigerating plant is located on a flat on the starboard side of the engine room and is supplied complete by the York Manufacturing Company, York, Pa. There are two fifteen-ton twin cylinder CO_2 machines, with all necessary pumps, coolers, etc. On the upper deck is an ice-making machine with a capacity of 1,000 pounds of ice per day.

The ship's meat rooms are located on the upper deck over hold No. 6, and are cork insulated with tile flooring. The cargo meat room of 4,032 cubic feet capacity is on the port side, and two provision meat rooms contain 6,021 cubic feet. In addition are the following cold storage spaces: Butter and eggs, 665 cubic feet; fish, 1,140 cubic feet; poultry, 980 cubic feet; vegetables, 1,405 cubic feet. In addition to the upper deck cold storage spaces, large built-in refrigerators in the first-class pantry, wine room and bar room are also cooled by brine pipes from the refrigerating plant.

A modern laundry on the port side of the upper deck contains a motor-driven washing machine, extractor, flat ironer, and tumbler dryer, and an electric skirt iron table. This outfit was supplied by the Troy Laundry Machine Company, Troy, N. Y.

The Rich fire extinguishing system is installed in the cargo holds, with detector cabinet in the pilot house and two control cabinets on the shade deck. The first-class staterooms and crew spaces are protected by the Aero fire alarm system, with indicators in engine room and pilot house.

Pneumercators are installed in the wing fuel oil tanks abreast the boiler rooms and an automatic alarm indicates when these tanks are filled.

Electric Plant

The electrical equipment on this ship is supplied from four 50 kilowatt, 115-volt compound wound General Electric Company generators, driven by Terry steam turbines, and operating at 250 pounds steam pressure. A 5-kilowatt gasoline engine-driven emergency generator set is located in a house on the starboard side of the boat deck house top.

The main switchboard, of 7 panels, is of Bethlehem manufacture and contains all the necessary switches and apparatus for control of the generators and distribution of ship's service. Approximately 1,800 lights are installed on the ship. Cargo lights are located on brackets on each side of each kingpost, and twelve cluster lights of six lamps each are provided for the holds.

A Sperry gyro compass outfit is installed, with a master compass on the upper deck connected to three steering repeaters and two peloruses.

Propelling Machinery

The two main driving units consist of Curtis marine type impulse turbines made at the Fore River Plant of the Bethlehem Shipbuilding Corporation, Ltd., operating through a two-pinion single-reduction gear supplied by the Falk Company, Milwaukee, Wis. One pinion connects to the high pressure turbine through a flexible pin coupling and the other pinion connects to the low pressure and reverse turbines, which are built into the same casing, in like manner. When the throttle is provided with steam at 250 pounds gage and 75 degrees F. superheat and a vacuum of 28 inches is maintained in the low pressure turbine exhaust, this unit will develop over 6,000 shaft horsepower at 125 revolutions per minute, and consume 10 pounds of steam per shaft horsepower per hour.

The Turbines

The turbines are of the multi-stage impulse type and are made up of a number of wheels, each running in a separate compartment. The clearances between the stationary and moving parts are made large enough to avoid all danger of their striking and without loss of efficiency. Leakage of steam between the diaphragm and shaft is prevented by the use of labyrinth packing rings of soft composition.

The high pressure turbine, which consists of one two-row stage and eleven single-row stages, measures 6 feet 3½ inches between centers of bearings and has a maximum diameter of 5 feet 3 inches. The low pressure turbine has seven single-row stages and the reverse turbine has two two-row stages. These two turbines have a common casing and shaft. Their combined length between bearing centers is 6 feet 5½ inches and their maximum width measures 8 feet 4 inches.

Each turbine casing is divided into four sections by a horizontal and a vertical joint; which are carefully machined and scraped and made up without packing. Cast steel is used in the steam inlet end of the high pressure turbine to withstand the high steam pressure and superheat in the steam chest, which is in the upper half, without excessive weight. The other casings are made as light as practical, of close grained cast iron, and are heavily ribbed for strength.

Thirty percent of the first stage ahead steam nozzles are controlled by two valves built into the steam chest. The operation of these valves maintains greater efficiency at low speeds. The astern steam chest is contained in the upper half of the back end of the low pressure casing and is made strong enough for full boiler pressure by increasing the wall thickness above the rest of the casing.

In order to secure the best possible alinement and to render the casings as rigid as possible the bearing pedestals have been made as part of the lower half casings. Ample openings are provided for steam inlets to all the steam chests and for the exhausts from both casings, and drain connections are provided wherever necessary.

The nozzles are of two styles, the machined and the cast-in. The first stage high pressure and astern nozzles are expanding nozzles of the machined type and are made by drilling and reaming holes at the proper angle and correct location in

monel metal plates, bolted to the steam chests. The other stage nozzles, which, excepting the second stage astern, are non-expanding, are cored openings in the cast-iron diaphragms or nozzle plates with nickel steel blades cast in at the best angle and distance to divide them into correctly formed nozzles. All cast-in nozzles are filed smooth and carefully to size for high efficiency.

The diaphragms which form the walls of the stage compartments are made of close grained cast iron properly designed to withstand the pressure difference between the adjacent stages.

The turbine wheels are high grade open hearth steel forgings carefully designed for low stresses and smoothly finished to reduce the windage losses. They are shrunk on the shaft and are also keyed with steel keys and are grooved at the periphery to take the blade roots. Vent holes in webs are provided to overcome slight unbalance in steam pressure between front and back of wheel.

The turbine shafts are accurately machined steel forgings so proportioned that their critical speeds are well above the running speeds. They are fitted with removable labyrinth packing sleeves, thrust collars, squealer rings, worms for governor drive, and keys for the wheels and couplings.

The turbine buckets are made of non-corrosive material, capable of withstanding exceptionally high stresses. Each bucket is made true to gage, having a dovetail shaped root which fits accurately into a channel of the same section, machined in the rim of the wheel. A shroud ring is riveted to the outer ends of the buckets, and made 1/32-inch wider than the bucket section, this excess being all on the steam inlet side of the bucket. The stationary intermediate buckets between two moving rows of the double row wheels are made and assembled in a similar manner to the buckets of the wheels.

The turbine bearings are 7 inches by 9 inches of the shell type. They are of cast-iron lined, with high grade babbitt metal bored and scraped to size. The shells are of spherical form split for easy removal and supplied with large oil connections. The thrust bearing and squealer ring housings are cast with the forward bearing shells for easy alinement, and composition packing rings are fitted to the bearings and their cast iron covers to prevent loss of oil.

Between the ends of the turbine casings and shafts, the steam packing and sealing stuffing boxes are of the labyrinth type and consist of soft composition rings, which fit snugly to labyrinth sleeves shrunk on the shafts.

Double thrust bearings of the Kingsbury type are fitted to the forward ends of the turbine and reduction gear shafts. They take the unbalanced turbine or propeller thrusts in both directions. These bearings are of steel with composition shoes and are plentifully supplied with oil under pressure.

Brass squealer rings made in halves are fitted into grooves provided in the forward bearing shells of each turbine to give warning when the wheel clearances become too small.

The turbine micrometer is located at the end of each turbine shaft accurately to check the blade clearances. This consists of a steel pin operated by a lever which moves over a graduated scale and by which it is moved up until it touches the end of the shaft.

A pin coupling transmits power between each turbine and its reduction gear pinion. A flange is carried on each of the adjacent ends of these shafts. Twelve hardened steel pins are firmly bolted into one of these flanges and are inserted into holes in the other flange.

The turning gear consists of a removable ratchet wrench which fits the squared end of the reduction gear pinion shaft.

Governors

Constant acting, non-tripping speed control governors are mounted at the forward end of each turbine, and are driven by steel worms on the turbine shafts. These governors, which are of the centrifugal type, operate pilot valves which regulate the main steam governor. Easy and rapid operation is secured by ball bearings, excellent lubrication and light moving parts. The governor valve is of cast steel with a monel metal valve disk and seat.

The cross connection pipes between the turbines are of copper and are provided with valves so that in normal operation the high pressure turbine exhausts into the steam inlet end of the low pressure turbine. In case of accident to the low pressure turbine, the high pressure turbine can exhaust direct to the main condenser. Provision is also made so that in case of accident to the high pressure turbine steam from the main steam line can be directed into the low pressure turbine.

Lagging of magnesia blocks held in place with wire and covered with sheet steel plates is used on the high pressure turbine and the high pressure ends of the low pressure turbine to minimize the radiation losses. The horizontal casing joints are fitted with removable plates and bags of magnesia are used instead of the blocks to facilitate overhauling.

Maneuvering Valves

The maneuvering valves are of the quick operating, balanced, single port type and both ahead and astern valves are operated by the same handwheel. When the operating handwheel is in mid-position both valves are closed. The ahead throttle valve is opened by turning the handwheel to the left and the astern throttle valve by turning the handwheel to the right. The handwheel must always be brought back to neutral position in closing one valve and opening the other, so that both valves cannot be open at the same time. The maneuvering valve body is of cast steel and the valve disks and seats are of monel metal to withstand the high pressure and superheat.

A cast steel steam strainer with a removable monel metal basket is placed in the main steam line just before the governor valve to prevent any foreign material entering the turbine.

Reduction Gears

The reduction gears are of single reduction, double herringbone type with the gear and two pinions all in one horizontal plane. The gears are of cast steel, split horizontally at the hub to eliminate shrinkage strains. The rims, arms and hubs are cast in one piece and carefully annealed and machined. They are firmly secured to the shaft to insure accurate alinement. The gear shafts are steel forgings supported by two bearings of the shell type, lined with babbitt metal and are each fitted with a removable thrust bearing collar at the forward end.

The pinions are of chrome nickel steel accurately machined and are each supported by three bearings of the babbitt-lined shell type. They are carefully proportioned to secure equal distribution of tooth pressure by minimizing the cross bending and torsional deflection.

The cast-iron frame has been carefully shaped and ribbed to secure rigidity and reduce vibration and noise. The oil pans below the gears are of cast iron and the gear case covers are of sheet steel suitably lined to reduce noise. Hand holes are provided for access to the pinions and gears and for observing the lubrication.

Lubricating System

The gears and pinions, when running either ahead or astern, are lubricated at their points of contact by sheets of oil sprayed from oil sprays. The sprays are connected to an external manifold and may be removed together with the manifold, for cleaning, without lifting the gear case cover. The astern sprays are controlled by valves so that they may be cut off at all times except when ship is maneuvering.

All parts of the turbines and reduction gears requiring

(*Continued on page* 211.)

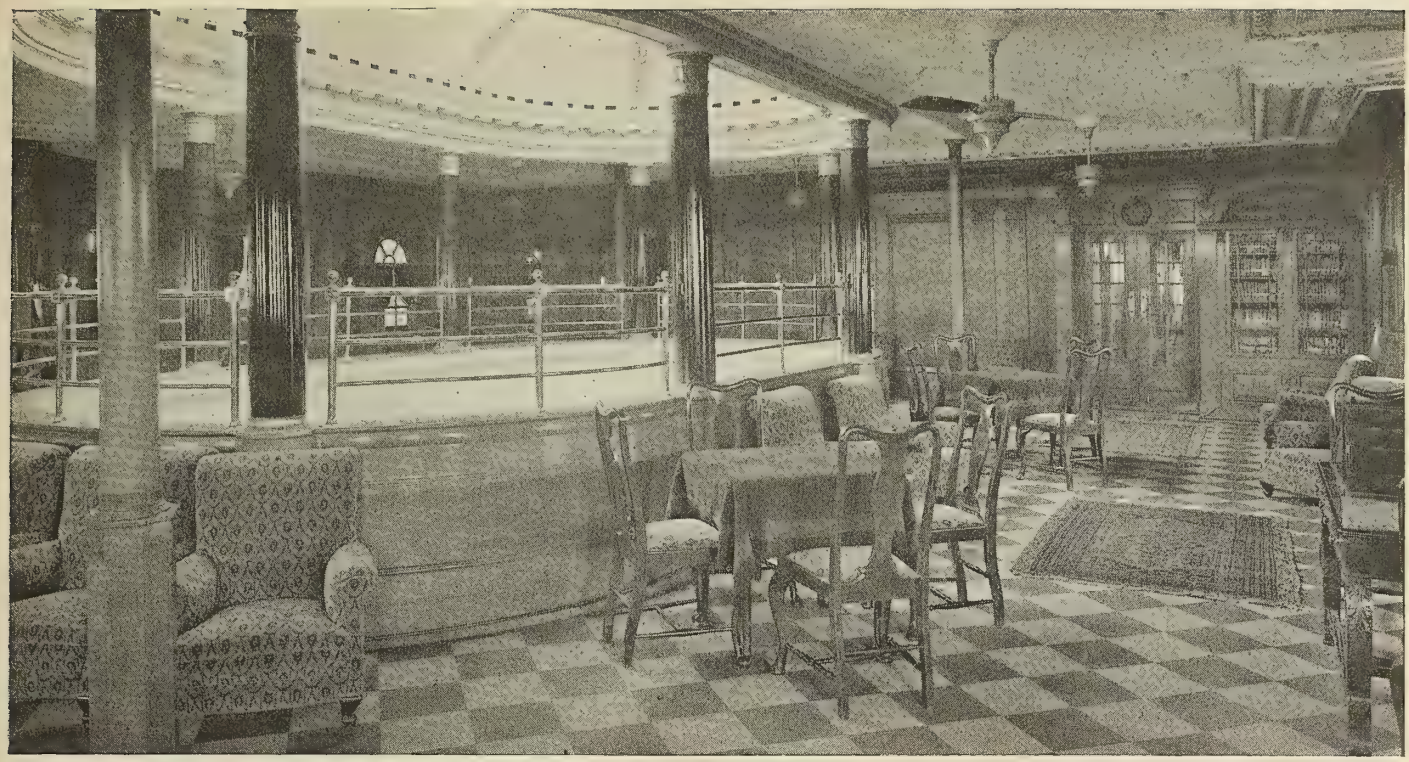


Fig. 1.—Music Saloon, Looking Aft, on S. S. *Naldera*

The P. and O. Liner Naldera

New Passenger and Mail Steamer Built by Messrs. Caird & Company for India and Australian Service

THE steamship *Naldera,* which was designed and built by Messrs. Caird & Company, Limited, Greenock, Scotland, for the passenger and mail service to India and Australia of the Peninsular & Oriental Steam Navigation Company, is one of the largest and most modern units of the fleet of that company. Her keel was laid in 1914, but construction was suspended on account of the war. Two years later work was resumed and she was launched in December, 1917. The vessel was first completed as a cargo carrier in 1918, and afterwards fitted out as a troopship and armed cruiser, but was never used for either of these services. After the conclusion of the armistice she was restored to her owners for completion along the lines originally intended. She was completed early in 1920 and made her maiden voyage in April of that year.

Of the three-stack cruiser stern type, the *Naldera* is designed for a speed of 18½ knots. Five of her decks, viz., the orlop, lower, main, upper and hurricane decks, extend the full length of the ship, while above these are the promenade and boat decks, each of which has a length of 440 feet and projects 2 feet 6 inches beyond the molded breadth of the vessel, as shown on the midship section. This provides additional space for promenades. Expansion joints are provided amidships in these two decks.

Accommodations are provided for first and second class passengers only. Most of the accommodations are in one, two, three and four berth staterooms, with a few special suites consisting of sitting room, bedroom and bath. All staterooms have lavatories with running water.

Two electric lifts are provided forward, which operate between the main and promenade decks, with landings at the intermediate decks.

On the main deck are the first and second class dining saloons and galleys, and some second class staterooms. First and second class staterooms occupy the greater part of the upper deck. On the hurricane deck are first class staterooms and the second class smoking room and music room. On the promenade deck are the gymnasium, first class music room, companion and divan, smoking room and verandas, and also some first class staterooms. Officers' quarters are provided on the boat deck. Some unusual features of these quarters are the veranda, promenade and smoking room provided for the engineer officers.

Cargo is carried in four holds forward and two holds aft. Two of the forward holds are fitted for carrying refrigerated cargo. Space is provided aft for mail and baggage. The cargo is handled entirely by hydraulic cranes, the power for which is furnished by a pump and hydraulic accumulator in the engine room.

The vessel is driven by two quadruple expansion reciprocating engines. Steam is supplied by ten coal-burning Scotch boilers operating under the Howden system of forced draft. The ashes are discharged through the bottom of the ship by two Stone hydraulic ash expellers. An ash hoist is also provided in each boiler room.

The electric generating plant consists of six compound engines, driving generators having a total output of 280 kilowatts at 105 volts. The electric installation includes some 3,000 lamps and over 800 cabin fans, as well as electrically operated lifts, galley machinery and gymnasium appliances. A 15-kilowatt oil engine driven emergency generating set is fitted on the promenade deck.

The *Naldera* is now operating between England and India and Australia and is giving excellent service. A sister ship, the *Narkunda,* has been completed at the Belfast yard of Harland & Wolff and will also operate between England and the British colonies of the southern hemisphere, carrying passengers, cargo and mail.

Fig. 2.—First Class Cabin

Fig. 3.—Main Lobby, Looking Aft

Fig. 4.—First Class Dining Saloon, Dome from Gallery

Fig. 5.—First Class Dining Saloon, Looking Forward

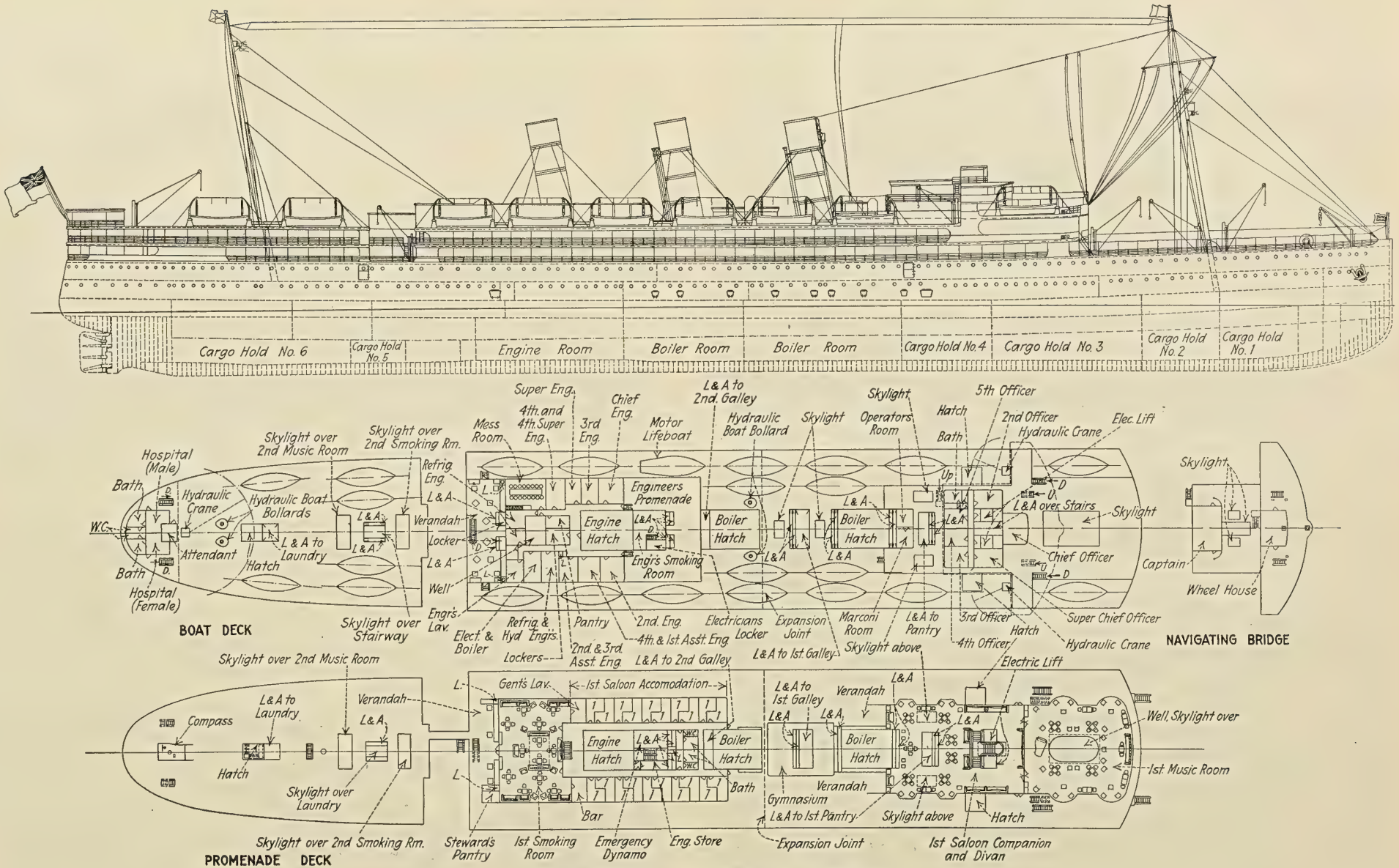


Fig. 6.—Profile and Deck Plans, S. S. *Naldera*

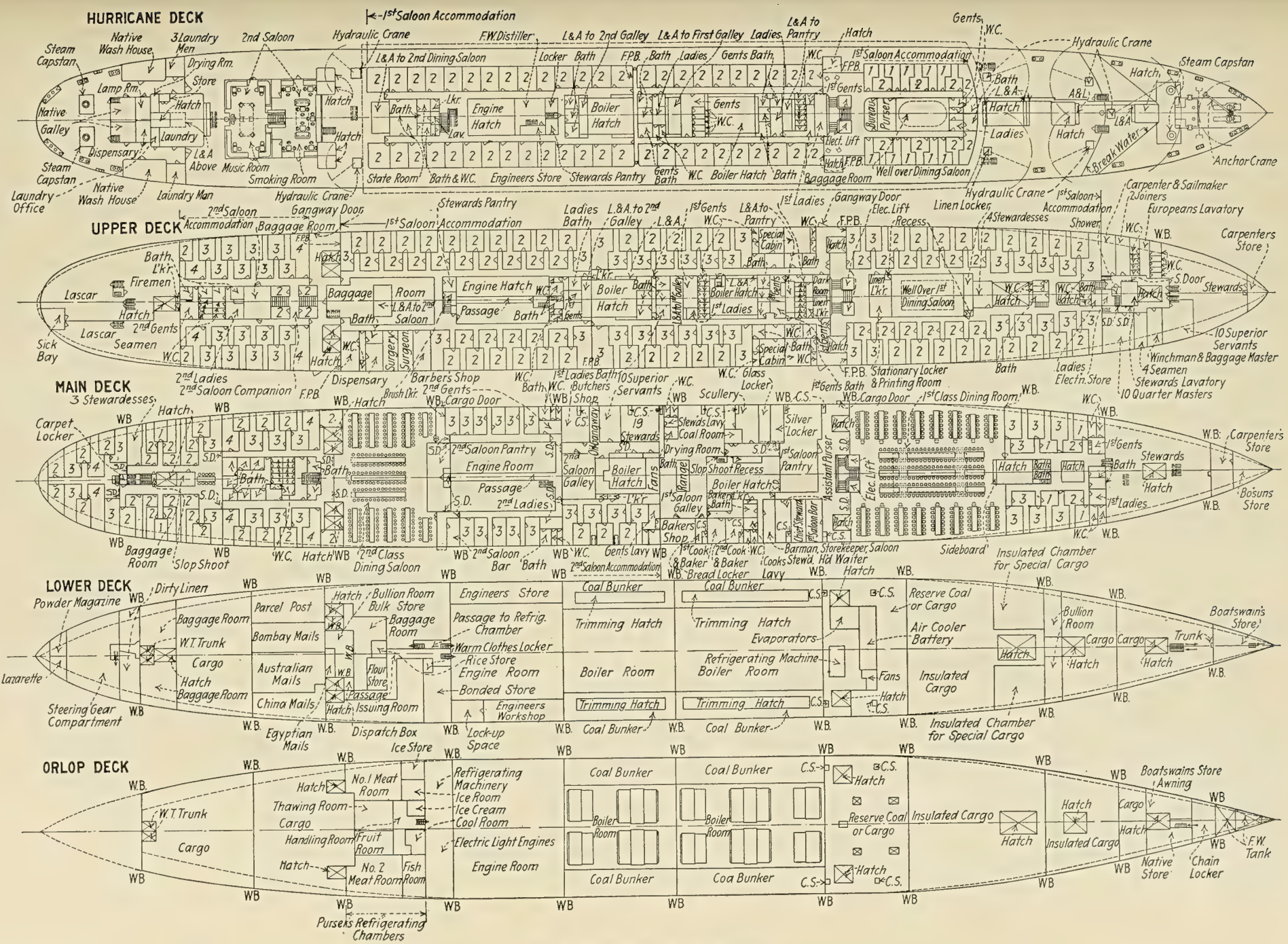


Fig. 7.—Deck Plans, S. S. *Naldera*

Peninsular and Oriental Liner Naldera

General Information

Service: Passenger and freight, England to India and Australia.
Builder: Messrs. Caird & Company, Greenock, Scotland.
Owner: Peninsular and Oriental Steam Navigation Company, London, Eng.

Characteristics

Length, overall .....605 feet
Length, B. P. .....581 feet
Beam, molded .....67 feet
Depth, molded, to upper deck.....40 feet 9 inches
Depth, keel to navigating bridge....77 feet
Draft, loaded .....29 feet 6¾ inches
Draft, light .....
Block coefficient .....
Midship section coefficient .....
Longitudinal coefficient .....
Speed, loaded, knots.....18½
Cruising radius, nautical miles.....
Framing .....Transverse
Class .....

Tonnages

(In tons of 2,240 pounds)

*Weight of hull.....
**Weight of propelling machinery.....
Deadweight capacity .....
Displacement .....

(In tons of 100 cubic feet)

Gross register 15,825
Net register .....

* Weight of hull includes hull proper, hull fittings, equipment and outfit.
** Weight of propelling machinery includes engines, boilers (wet), shafting, propellers and machinery space auxiliaries.

Canal Ratings

(In tons of 100 cubic feet)

Suez .....
Panama .....

Complement

Deck officers .....
Deck crew .....
Engineer officers .....
Engineer crew .....
Purser's and steward's department.....

Total officers and crew..... 462
First-class passengers 426
Second-class passengers 247

Total passengers 673
Total complement 1,135

Handling Equipment

	No.	Type	Capacity	Length
Masts	2	Pole		135 feet above L. W. L.
Derrick posts			None	
Booms			None	
Discharging capacity				

Deck Machinery

Steering gear.....Steam tiller, telemotor controlled, hydraulic auxiliary gear.
Windlass (1) .....
Capstans (4) .....steam
Cranes (10) .....hydraulic
Boat bollards (4).....hydraulic

Life Saving Equipment

	No.	Type	Length
Lifeboats	23	1 motor	

Propelling Machinery

Boilers

Number 10
Type ...4 dbl. ended; 6 single ended Scotch
Length .....double ended, 20 feet single ended, 11 feet 9 inches
Diameter.....double ended, 16 feet 6 inches; single ended; 15 feet 2 inches
Furnaces.....8 in each D. E.; 3 in each S. E.
Fuel .....Coal
Draft .....Forced
Total heating surface....39,628 square feet
Total grate surface..... 958 square feet
Superheat, degrees F. .....
Working pressure, pounds per square inch 215
Normal fuel consumption:
Per day, tons .....
Per horsepower hour, pounds.....
Normal steam production:
Per hour per pound of fuel.....
Total per hour .....

Engines

Number 2
Type....Quadruple expansion reciprocating
Size.....32½ inches, 46½ inches, 67 inches and 96 inches, by 50 inches.
Horsepower, total indicated.....15,000

Propellers

Number 2
Type.....3-bladed, manganese bronze
Weight .....
Diameter .....19 feet
Pitch .....24 feet
R. P. M. 90
Projected area .....
Developed area, each....278.25 square feet

Auxiliary Machinery

Refrigerating Machinery
1 Haslam CO_2 unit for cargo
1 Haslam CO_2 unit for stores

Engine Room
Condensers.....2 main, Weir "Uniflux;" cooling surface, 7,500 square feet, each.
1 auxiliary, 953.35 square feet cooling surface, Caird & Co.
Evaporators.....2-40-ton Weir
Distiller .....
Filters..1 main feed, double for 6-inch pipe
1 auxiliary feed, for 3-inch pipe
Feed water heater..1 Weir, 32-inch, direct contact
Pumps
2 Tangye's centrifugal circulating, impeller pipe 22 inches; engine 13 inches by 11 inches.
2 Weir dual air, 15 inches by 26 inches by 18 inches.
1 Weir bilge, 10½ inches by 13 inches by 24 inches.
1 Weir sanitary 10½ inches by 13 inches by 24 inches.
1 Weir ballast, 10½ inches by 13 inches by 24 inches.
3 Weir main feed, 20 inches by 14 inches by 32 inches.
1 Weir auxiliary feed, 9½ inches by 7 inches by 18 inches.
1 Weir fresh water.
1 Hydraulic air and circulating
1 Waste oil.
Accumulator....1 Brown Bros. hydraulic; ram, 12 inches; stroke, 5 feet 6 inches; pressure, 1,000 pounds per square inch.
Hydraulic pumping engine..1 Brown Bros.
Air extractor.....1 Hallet, 6-inch pipe
Float tank.....1 Caird & Co.
Vent fans.....2 Howden, 42-inch
Steam separator.....2 Caird & Co.
Turning engine.....2 Caird & Co., 8 inches by 8 inches.

Electrical Equipment
Generators.....6-45 K. W. Belliss-Morcom 1-15 K. W. emergency, oil engine driven.
Lamps, number 3,000
Cabin fans, number..... 800
Radio set

Boiler Rooms
Forced draft fans.....4 Howden, 78-inch
Vent fans.....2 Howden, 42-inch
Ash expeller.....2 Stone
Ash hoist....1 Alley & McCellan, engine 4-inch by 5-inch

Holds

No.	Length	Hatches
1	34'8"	12'0" x 9'0"
2	34'8"	12'0" x 11'0"
3	65'0"	18'0" x 12'0"
4	39'0"	(2) 9'0" x 8'0"
5	26'0"	(2) 9'0" x 6'6"
6	78'0"	9'0" x 7'0"

Capacities

Cargo Space

Compartment	Cu. Ft.
No. 1 Cargo Hold	
No. 2 " "	
No. 3 " "	
No. 4 " "	
No. 5 " "	
No. 6 " "	
No. 4 lower 'tween decks (coal or cargo)	
No. 5 " " "	
No. 6 " " "	
No. 1 upper 'tween decks	
No. 2 " " "	
No. 4 " " " (coal or cargo)	
No. 6 " " "	
No. 1 Hach trunk	
No. 2 " "	
No. 3 " "	
No. 4 " "	
No. 5 " "	
No. 6 " "	
Total cargo space	253,320

Refrigerated Space

	Cu. Ft.
Total refrigerated cargo space.....	103,360
Refrigerated space for ships' use..	15,670
Total	119,030

Bunkers

Compartment	Cu. Ft.	Tons
Forward side bunker, port		
" " " starboard		
Aft " " port		
" " " starboard		
Total permanent bunkers		2,940
No. 4 lower 'tween decks		
No. 4 upper " "		
Total bunker space		

Tanks

Compartment	Cu. Ft.	Tons F. W.	Tons S. W.
Fresh Water Tanks.....		886	
Ballast Tanks.....			1,890
Total		886	1,890

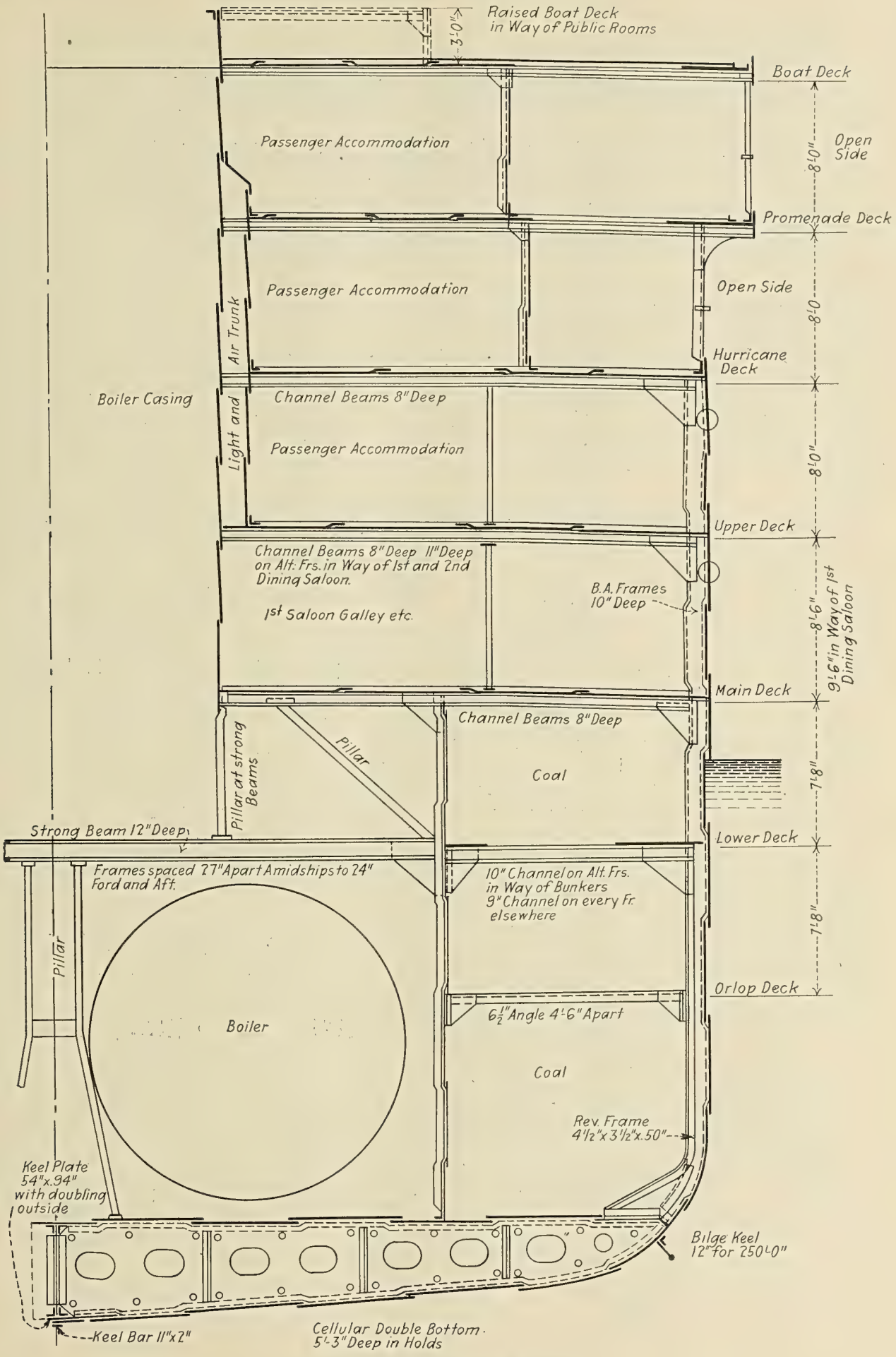


Fig. 8.—Midship Section, S. S. *Naldera*

Mail and Passenger Steamer Naldera

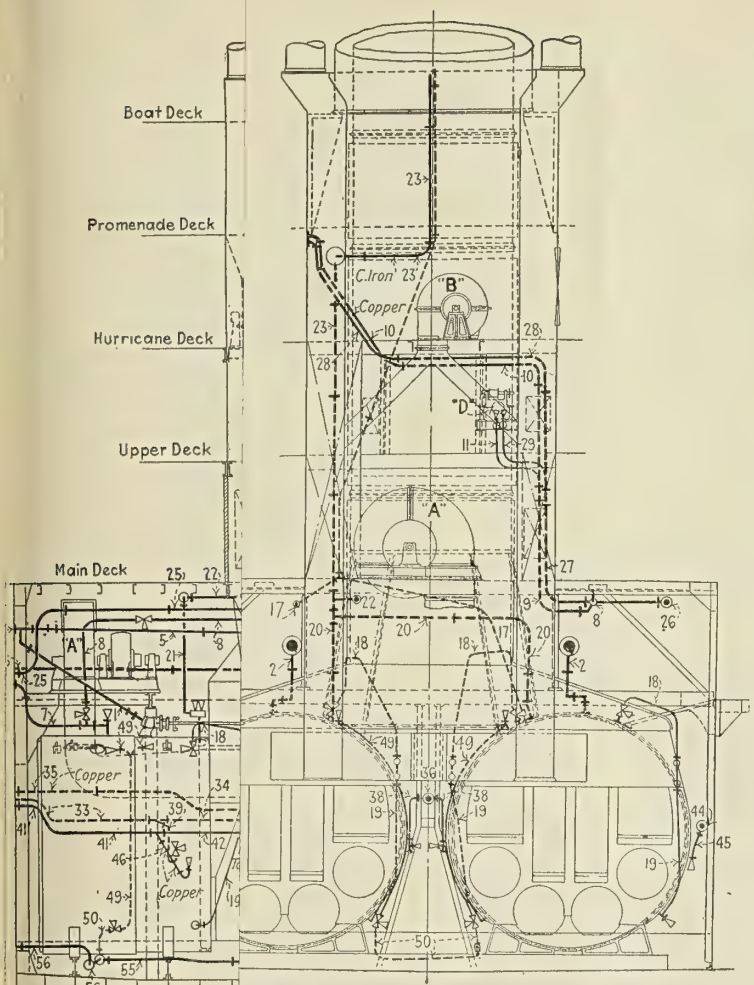
ARRANGEMENT OF MACHINERY AND PIPING

LIST OF ENGINE ROOM PIPES

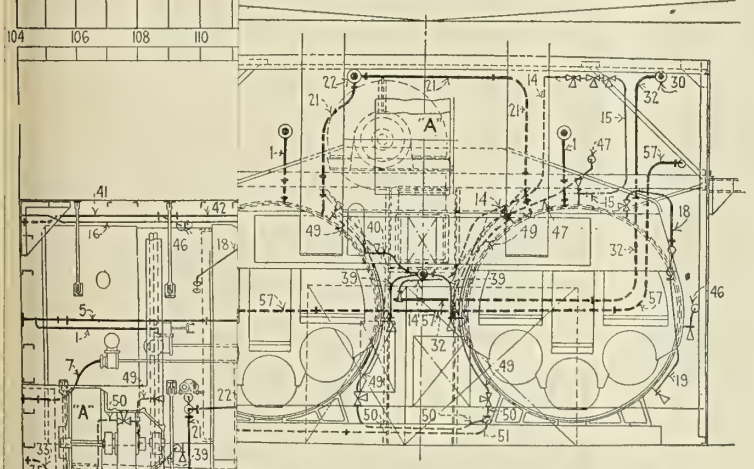
Pc. No.	Size	Material	Material
1	13 '	W. I	Main Steam to Engines
2	9½"	W. I	" " " Cross Conn.
3	12½"	W. I	" " " Engines P. & S.
4	6 "	C. I. Valve	" " " Aux.
5	6 "	SDS & No.1 Copp.	Aux. Steam to Aux. P. & S. (Ford. Bhd.)
6	6½"	"	" " " " Stb. Side
7	5¾"	S. D. Steel	" " " " " "
8	4¼"	SDS & No.4 Copp.	" " " " Aft. End
9	6 "	S. D. Steel	" " " " Port Side
10	5¾"	"	" " " " " "
11	4 "	"	" " " Hydr. Accum.
12	1¼"	No. 9 Copp.	" " " Aux. Feed Pump (Direct)
13	1¼"	"	" " " " " " (Control)..
14	3¼"	S. D. Steel	" " " Steering Eng.
15	3¼"	Copp...	Main Steam to St. Eng. from D. E. Boiler
16	1½"	S.D . Steel	Aux. Steam to Hydr. Air & Circ. Pump
17	2½"	"	" " " Main Feed Pumps Ht. Con
18	2½"	"	" " " " " " Tank Con.
19	1¾"	"	" " " Ballast Pump
20	1¾"	"	" " " San. Pump (Direct)
21	1¾"	No. 9 Copp.	" " " " " " (Control)..
22	1¾"	S. D. Steel	" " " Air Pump P. & S.
23	1¾"	"	" " " Bilge Pump
24	2¾"	"	" " " Evap. (Combined)
25	2 "	"	" " " Evap.
26	1¼"	No. 9 Copp.	" " " Turning Eng. P. & S.
27	3½"	S. D. Steel	" " " Circ. Pump P. & S.
28	2½"	"	" " " Aft. Refr.
29	1½'	"	" " " Fire Pipes
30	½"	Copper	" " " Waste Oil Pump
31	2½"	SDS & No.7 Copp.	" " " Generating Sets
32	¾"	No. 10 Copp.	" " " Fresh Water Pump Direct
32A	¾"	"	" " " " " " (Contro)
33	½"	Copp.	" " for Cleaning Main Feed Filters
34	½"	"	" " " " " Aux. Feed Filter
35	2¼"	"	" " to Pantries
36		"	" " " Distillers and Bath Heater
38	¾"	No. 10 Copp.	" " " Hyd. Tank
38A	½"	Copp.	" " " Impermeator
38B	1 "	"	" " " Emer. Bilge Pump Ejector
39	4½"	W I. & No. 11 Copp	Exh. From Gen. Sets
40	7½"	W. I.	" " " "
41	9 "	C. I.	" " " "
42	9 "	W.I. & No.10Copp.	" " " " to Cond. Direct
43	9 "	W. I.	" " " " to Exh. Main
44	4 "	"	" " Aft. Refr. to Exh. Main
45	7 "	W.I. & No.10 Copp.	Exh. Main
46	7 "	No 10 Copp.	" from Aux. to Main Cond.
46A	7 "	W. I.	" " " " Aux. "
47	7 "	W.I. & No.10 Copp.	" " " " L. P. Casing
48	7 "	W. I.	" " " " Heater
49	5½"	W.I. & No.11 Copp.	Vapour from Evap. to Cond.
50	5½"	W. I.	" " " " Exh. Main
51	4 "	No. 12 Copp.	" " "
52	4½"	W.I. & No.11 Copp.	Exh. from Circulating Pump (P. & S.)
53	1¼"	No. 13 Copp.	" " Turning Eng. (P. & S.)
54	2¼"	W.I. & No.13 Copp.	" " Air Pump (P. & S.)
55	1¼"	No. 13 Copp.	" " Rev. Eng. (P. & S.)
56	2 "	W. I.	" " Bilge Pump
57	2¾"	"	" " Bilge & San. Pumps
58	3¼"	"	" " " " & Ballast Pumps
59	8 "	"	Steam from L. P. Casing to Heater (P.&S.)
60	1 "	No. 14 Copp.	Exh. from Fresh Water Pump
61	1¾"	W. I.	" " Fresh Water & Aux. Feed Pump
62	3¾"	"	" " Fr. Wa. & Aux. Fd. Pp. 1 Mn. F.
63	3 "	"	" " Stb. Main Feed Pump
64	4½"	"	" " Aux. For. E. of E. R. to Exh. M.
65	5 "	No. 11 Copp.	" " St. Eng. & Capstan to Cond.
66	5 "	W. I.	" " " " " " Exh. Main
67	6 "		" " Aux. to Atmosphere
68	½"	Copp.	" " Oil Pump to Exh. Main
69	1¾"		" " Hyd. Eng. Air & Cir. Pump
45A	6 "	W. I.	" " Aux. P. S. Aft. End of Eng. Rm.
69A	1¾"	W. I.	" " Hyd. Eng. A. & C. Pp. to Exh. M
70	22 "	C.I. & No. 5 Copp.	Circ. Pump Suct. (P. & S.)
71	22 "	C.I. & No. 5 Copp.	" " Disch. to Cond. (P. & S.)
72	22 "	C.I. & No. 5 Copp.	" " " Ovbd. (P. & S.)
73	9 "	W. I. & C. I.	" " Cross Conn. Betw. Cond.
74	7½"	W. I.	Aur Pump Disch. to Float Tank (P.& S.)
75	8½"	W. I. & C. I.	Wet Air Pump Suct. from Cond.
76	6¼"	W.I. & No. 9 Copp	" " " " Cross Conn.
77	5½"	"	Dry Air Pump Suct. from Cond. (P. & S.)
78	4 "	W.I. & No. 10 Copp	" " " " Cross Conn.

Pc. No.	Size	Material	Remarks
79	1½"	W. I.	Circ. Wa. for Air Pmp. Cool. Pipes (Inlet)
80	1½"	"	" " from " " " (Outlet)..
81	6 "	No. 8 Copp.	Bilge Pump Suct. from Main Bilge
82	5 "	No. 9 Copp.	" " " " Ballast Tanks
83	4 "	C.I. & No. 10 Copp	" " " " Separate Bilge For.
84	4 "	No. 10 Copp.	" " " " " " " Aft.
85	6 "	No. 8 Copp.	San. and Ballast Pump Suct. from Sea
86	6 "	"	" Pump Suct. from Sea
87	6 "	"	" " " " Main Bilge
88	6 "	"	Ballast Pump Suct. from Sea
89	6 "	"	" " " " Main Bilge
90	5 "	No. 9 Copp.	" " " " Aft. Ballast Tanks
91			" " " " Cond. W/ways
92	5 "	No. 9 Copp.	" " " " Ford. Ballast Tanks
93	4 "	No. 10 Copp.	" " " " Separate Bilge
94	5 "	Lead	Flooding Pipe for Ford. Ballast Tanks
95	5 "	"	" " " " Aft. " "
96	4½"	No. 9 Copp.	Main Feed Pump Suct. from Ballast Main
97	4½"	S. D. Steel	" " " " " Boilers
98	7 "	W. I.	" " " " " Float Tank
99	7½"	"	" " " " " Heater
100	3½"	No. 10 Copp.	Aux. Feed Pump Suct. from Bilge
101	3½"	"	" " " " " Float Tank
102			" " " " " Cond.W/way
103	3½"	W. I.	" " " " " Sea
104	3 "	"	" " " " " F. W. Tanks
105	2 "	"	" " " " " No. 1 TankFW
106	1 "	"	Conn. from No. 1 Tank to Port Cond.
107	1 "	No. 14 Copp.	Sup. Feed to Main Cond.
108	1 "	W. I.	" " " Stb. Cond. from Bal. Main
109			Hot Water Supply from Mn. & Aux. Cond.
110	3½"	W. I.	Drain from Aux. Cond. to Fl. Tk. or A. Pp.
111	3½"	"	" " " " " Air Pump
112	2 "	No. 12 Copp.	Soda Water Conn...to Main Cond.
113	2 "	W.I. & No.12 Copp.	" " " From Float Tank
114	1 "	No. 14 Copp.	" " " " Bucket
118	6 "	Gal. W. I.	Bilge Pump Disch. Ovbd.
119	6 "	W. I.	San. Pump Separate Disch. to Deck
120	6 "	"	Ballast Pump Separate Disch. to Deck
121	5 "	"	Ballast & San. Pump Disch. to Aux. Cond.
122	6 "	Gal. W. I.	" " " " " Ovbd.
123	6 "	W.I. & No. 8 Copp.	Ballast Pump Disch. to Main Cond.
124		" "	" " " to Hot Water Main
125	6 "	S. D. Steel	Main Feed Pump Disch. Thru Fil. to Heat.
126	4 "	W. I.	" " " " Ovbd.
127	5½"	S. D. Steel	" " " " to Aux. Feed
128	6 "	"	" " " " to Main Feed
129	4¾"	"	" " " " to Aux. Feed (Port)
130	¾"	"	Conn. from Aux. Feed for Fil. Launch Blr.
131	3 "	W. I.	Aux. Feed Pump Disch. Ovbd.
132	3 "	SDS & No. 6 Copp.	" " " " Thru Fil. to Aux. Feed
133		W. I.	" " " " to Hot Water Main
134			" " " " to F. W. Main
135	5 "	No. 9 Copp.	Aux. Cond. Disch. Ovbd.
136	6 "	W. I.	Heater Overflow to Overflow Tank
137	3 "	"	Drain from Overflow Tank to Float Tank
138	2½"	"	Water Service from Rising Main
139	4 "	"	" " Supply from Sea
140	2¼"	"	" " Disch. Ovbd.
141	2 "	No. 13 Copp.	Evap. Feed from Hot Water Main
142	2 "	"	" " " Rising Mains
143	2 "	W. I.	" " (Combined)
144	1¾"	"	" " to Each Evap.
145	2½"	"	" Blow Down
146	1½"	"	" Branch to Sea
147	5¾"	"	" Safety Valve Overflow
148	6 "	C. I.	Bilge Injection
149	6 "	C. I. & Lead	Main Bilge
150	4 "	"	Separate Bilge Ford.
151	4 "	"	" " Aft.
152	5 "	"	Ballast Main Ford.
153	5 "	"	" " Aft.
154	3 "		Hot Water Main
155	4½"	W. I.	Hyd. Air Pump Disch. to Float Tank
156	4½"	No. 8 Copp.	" " & Cir. Pump Suct. from Sea
157	4½"	W. I.	" " " " " Disch. Ovbd.
158	3½"	"	Aft. Refr. Suct. from Sea
159	3½"	W.I. & No.10Copp.	" " Disch. Ovbd.
160	1¼"	W. I.	" " Feed Disch. to Float Tank
161	2¾"	"	" " Aux. Water Sup. from Bal. Pmp
162	1¾"	"	Drain from Ford. Refrig. to Float Tank
163	4 "	"	Air Pipe from Float Tank

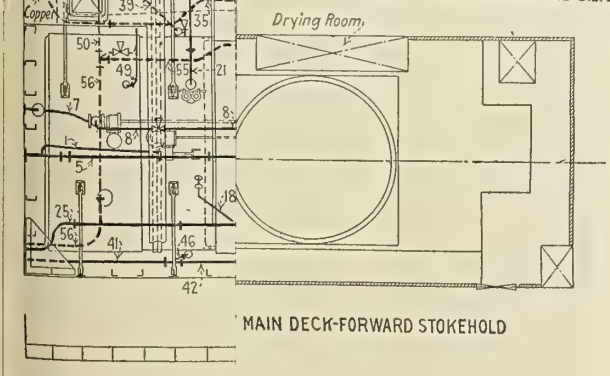
RA



T FRAME 137 LOOKING FORWARD ON FORWARD D.E. BOILERS



T FRAME 151 LOOKING FORWARD ON FORWARD S.E. BOILERS



MAIN DECK-FORWARD STOKEHOLD

LIST OF BOILER ROOM PIPES

Pc. No.	Dia.	Thickness	Material	Remarks
1	6″	9/32″	W. Iron	Main Steam from S. E. Boilers
2	8″	11/32″	"	" " " D. E. "
3	9″	13/32″	"	" " " For'd S. E. & D. E. Boilers
4	10″	7/16″	"	" " " " B. R.
5	12″	½″	"	" " " For'd B. R. & Aft. D. E. Boilers
6	13″		G. I. Y Piece	" " Combined
7	6″	1 W.G.	Copper	Aux. Steam to Eng. Room
8	4″	¼″	S. D. S.	" " " Deck & For'd Refr.
9	4″	¼″	S. D. S.	" " " " & Ash Hoist
10	4″	5 W.G.	Copper	
		¼″	S. D. S.	" " " "
11	1″	W.G. 10	Copper	" " " Ash Hoist
12	3½″	3/16″	S. D. S.	" " " For'd Refr. & Ash Expeller
13	3¼″			" " " " Refr.
14	2″	3/16″	S. D. S.	" " " Ash Expellers
14A				" " " Bunkers (Fire Exting. Conn.)
15	3¼″	3/16″	S. D. S.	Steam to For'd Refr. from For'dS.E.Boiler (Stb.)
16	3¼″	3/16″	S. D. S.	" " Steering Engine
17	2″	8 W.G.	Copper	" " Whistle
		3/16	S. D. S.	
18	1½″	W.G. 6	Copper	" " Gage Glass
19	1¼″	6	"	Water " "
20	6½″	¼″	W. Iron	Waste Steam from D. E. Boilers
21	4¾″	W.G 5	"	" " " S. E. "
22	6¾″	¼″	"	" " " S. E. " Comb.
23	13¼″	W. G. 10	Copper	" " Up Funnel For'd B. R.
23	13¼″	¼″	W. Iron	" " " " " "
24	11½″	W. G. 11	Copper	" " " " Aft. "
24	11½″	¼″	W. Iron	" " " " " "
25	6″	¼″	"	Aux. Exhaust to Atmosphere
25	6″	W. G. 12	Copper	" " " "
26	5″	¼″	W. Iron	Exh. from Deck & For'd Refr.
27	5″	¼″	"	" " " " Ash Hoist
28	5″	11 W.G	Copper	" " Deck
		¼″	W. Iron	
29	1¼″	W. G. 13	Copper	" " Ash Hoist
30	5″	¼″	W. Iron	" " For'd Refr. & Ash Expeller
31	4½″			" " " "
32	4″	W. G. 5	W. Iron	Exh. from Ash Expeller
33	4¾″	¼″	S. D. S.	Main Feed to Aft. B. R.
34	4¼″	¼″	S. D. S.	" " " " " D. E. Boilers (Comb.)
35	5½″	¼″	S. D. S.	" " " For'd "
35	5½″	W. G. 1	Copper	" " " " "
36	4¾″	¼″	S. D. S.	" " " " " D.E. & S.E. Boil. (Com.)
37	3½″	3/16″	"	" " " " " For'd S.E. Boil. (Comb.)
38	3″	W.G. 6	Copper	" " " D. E. Boilers in For'd and Aft. B. R.
39	2½″	W.G. 7	"	" " " S. E. Boilers in For'd and Aft. B. R.
40	2″	W.G. 8	"	" " Conn. to Air Vessel in For'd B. R.
41	4¾″	¼″	S. D. S.	Aux. Feed Combined
42	4½″	¼″	S. D. S.	" " to Aft. D. E. Boilers & For'd B. R.
42	4½″	W.G. 3	Copper	" " " " " " " " " "
43	3¾″	3/16″	S. D. S.	" " " For'd B. R.
44	3¼″	3/16″	S. D. S.	" " " " D.E. & For'd S.E. Blrs. (Com.)
44	3¼″	W.G. 5	Copper	" " " " " " " " " "
45	3″	W.G. 6	"	" " " D. E. Boilers in For'd & Aft. B.R.
46	2½″	W.G. 7	"	" " " S. E. " " " " " "
46	2½″	3/16″	S. D. S.	" " " " " " " " " "
47	1¾″	3/16″	S. D. S.	For'd Refr. Feed Pump Disch. to Boiler & Float Tank.
48	1¾″	W.G. 6	W. Iron	For'd Refr. Feed Pump Disch. to Float Tank
49	1″	W.G. 8	Copper	Surface Blow Off
50	2″	3/16″	S. D. S.	Bottom Blow Off & Boiler Circ.
51	2″	3/16″	S. D. S.	" " " to Ship Side
52	2¾″	3/16″	"	Boiler Circ. For'd S. E. Boilers
53	3¼″	3/16″	"	" " " S. E. & D. E. Boilers
54	3½″	3/16″	"	" " from For'd B. R. (Comb.)
55	4″	3/16″	"	Boiler Circ. from For'd B.R. & Aft. D. E. Boiler
56	4½″	3/16″	"	Boiler Circ. Comb. to Feed Pump
57	4½″	W.G. 5	W. Iron	For'd Refr. Sea Suct.
58	1¼″	W.G. 7	"	Firemen's Water Service
59				Fire Conn. (Steam to Bunkers)
60				Conn. for Washing Out Boilers
61				Ballast Main
62				Bilge Main
63				Separate Bilge

BOILER ROOM AUXILIARIES

Mark	Purpose
A	Forced Draft Fan
B	Ventilating Fan
C	Ash Expeller
D	Ash Hoist

PASSENGER AND MAIL STEAMSHIP NALDERA

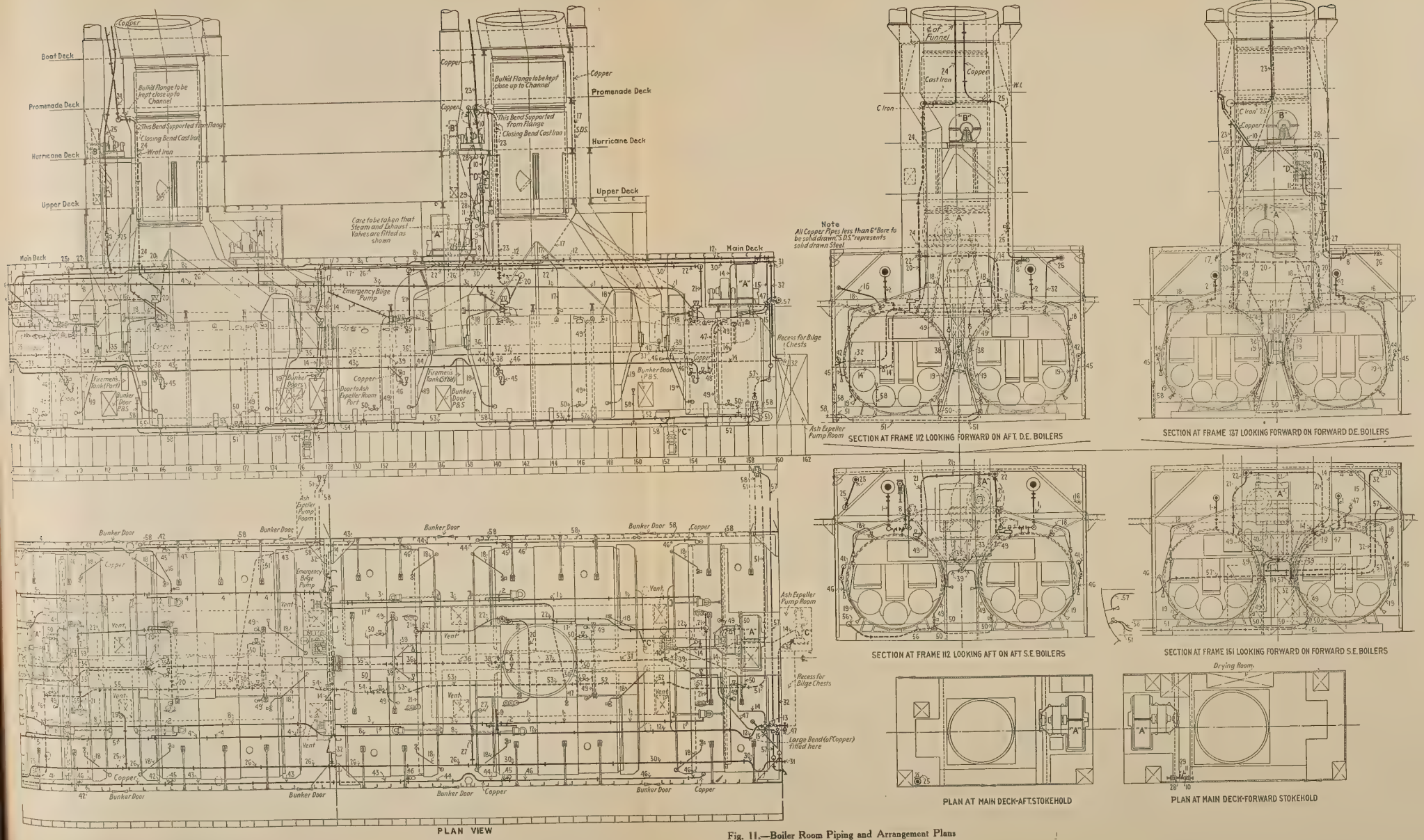


Fig. 11.—Boiler Room Piping and Arrangement Plans

LIST OF BOILER ROOM PIPES

Po. No.	Dia.	Thickness	Material	Remarks
1	6″	9/16″	W. Iron	Main Steam from S. E. Boilers
2	8″	11/16″	"	" " " D. E. "
3	9″	13/16″	"	" " " For'd S. E. & D. E. Boilers
4	10″	7/8″	"	" " " B. R.
5	12″	15/16″	"	" " " For'd B. R. & Aft. D. E. Boilers
6	13″		G. I. Y Piece	" " Combined
7	6″	1 W.G.	Copper	Aux. Steam to Eng. Room
8	4″	1/4″	S. D. S.	" " " Deck & For'd Refr.
9	4″	1/4″	S. D. S.	" " " " & Ash Hoist
10	4″	5 W.G.	Copper	
		1/4″	S. D. S.	" " " "
11	1″	W.G. 10	Copper	" " Ash Hoist
12	3 1/2″	7/16″	S. D. S.	" " " For'd Refr. & Ash Expeller
13	3 1/4″			" " " " Refr.
14	2″	5/16″	S. D. S.	" " " Ash Expellers
14A				" " " Bunkers (Fire Exting. Conn.)
15	3 1/4″	5/16″	S. D. S.	Steam to For'd Refr. from For'd S.E. Boiler (Stb.)
16	3 1/2″	5/16″	S. D. S.	" " Steering Engine
17	2″	6 W.G.	Copper	" " Whistle
		5/16	S. D. S.	
18	1 1/2″	W.G. 6	Copper	" " Gage Glass
19	1 1/4″	6	"	Water " "
20	6 1/2″	1/4″	W. Iron	Waste Steam from D. E. Boilers
21	4 1/2″	W.G 5	"	" " " S. E. "
22	8 1/2″	1/4″	"	" " " S. E. " Comb.
23	13 1/2″	W.G. 10	Copper	" " Up Funnel For'd B. R.
23	13 1/2″	1/4″	W. Iron	" " " " " "
24	11 1/2″	W.G. 11	Copper	" " " " Aft. "
24	11 1/2″	1/4″	W. Iron	" " " " " "
25	6″	1/2″	"	Aux. Exhaust to Atmosphere
25	6″	W.G. 12	Copper	" " " " "
26	5″	1/4″	W. Iron	Exh. from Deck & For'd Refr.
27	5″	1/4″	"	" " " " Ash Hoist
28	5″	11 W.G.	Copper	" " Deck
		1/2″	W. Iron	
29	1 1/2″	W.G. 13	Copper	" " Ash Hoist
30	5″	1/4″	W. Iron	" " For'd Refr. & Ash Expeller
31	4 1/2″		"	" " " "
32	4″	W.G. 5	W. Iron	Exh. from Ash Expeller
33	4 1/2″	1/4″	S. D. S.	Main Feed to Aft. B. R.
34	4 1/2″	1/4″	S. D. S.	" " " " D. E. Boilers (Comb.)
35	5 1/2″	1/4″	S. D. S.	" " " For'd "
35	5 1/2″	W.G. 1	Copper	" " " " "
36	4 1/4″	1/4″	S. D. S.	" " " " D.E. & S.E. Boil. (Com.)
37	3 1/2″	3/8″	"	" " " " For'd S.E. Boil. (Comb.)
38	3″	W.G. 6	Copper	" " " D. E. Boilers in For'd and Aft. B. R.
39	2 1/2″	W.G. 7	"	" " " S. E. Boilers in For'd and Aft. B. R.
40	2″	W.G. 8	"	" " Conn. to Air Vessel in For'd B. R.
41	4 1/4″	1/4″	S. D. S.	Aux. Feed Combined
42	4 1/2″	1/4″	S. D. S.	" " to Aft. D. E. Boilers & For'd B. R.
42	4 1/2″	W.G. 3	Copper	" " " " " " " "
43	3 1/4″	5/16″	S. D. S.	" " " For'd B. R.
44	3 1/4″	5/16″	S. D. S.	" " " " D.E. & For'd S.E. Blrs. (Com.)
44	3 1/4″	W.G. 5	Copper	" " " " " " " " " "
45	3″	W.G. 6	"	" " " D. E. Boilers in For'd & Aft. B.R.
46	2 1/2″	W.G. 7	"	" " " S. E. " " " " " "
46	2 1/2″	5/16″	S. D. S.	" " " " " " " " "
47	1 3/4″	5/16″	S. D. S.	For'd Refr. Feed Pump Disch. to Boiler & Float Tank.
48	1 3/4″	W.G. 6	W. Iron	For'd Refr. Feed Pump Disch. to Float Tank
49	1″	W.G. 8	Copper	Surface Blow Off
50	2″	1/4″	S. D. S.	Bottom Blow Off & Boiler Circ.
51	2″	1/4″	S. D. S.	" " " " to Ship Side
52	2 3/4″	5/16″	"	Boiler Circ. For'd S. E. Boilers
53	3 1/4″	5/16″	"	" " " " S. E. & D. E. Boilers
54	3 1/4″	5/16″	"	" " " from For'd B. R. (Comb.)
55	4″	5/16″	"	Boiler Circ. from For'd B.R. & Aft. D. E. Boiler
56	4 1/2″	5/16″	"	Boiler Circ. Comb. to Feed Pump
57	4 1/2″	W.G. 6	W. Iron	For'd Refr. Sea Suct.
58	1 1/4″	W.G. 7	"	Firemen's Water Service
59				Fire Conn. (Steam to Bunkers)
60				Conn. for Washing Out Boilers
61				Ballast Main
62				Bilge Main
63				Separate Bilge

BOILER ROOM AUXILIARIES

Mark	Purpose
A	Forced Draft Fan
B	Ventilating Fan
C	Ash Expeller
D	Ash Hoist

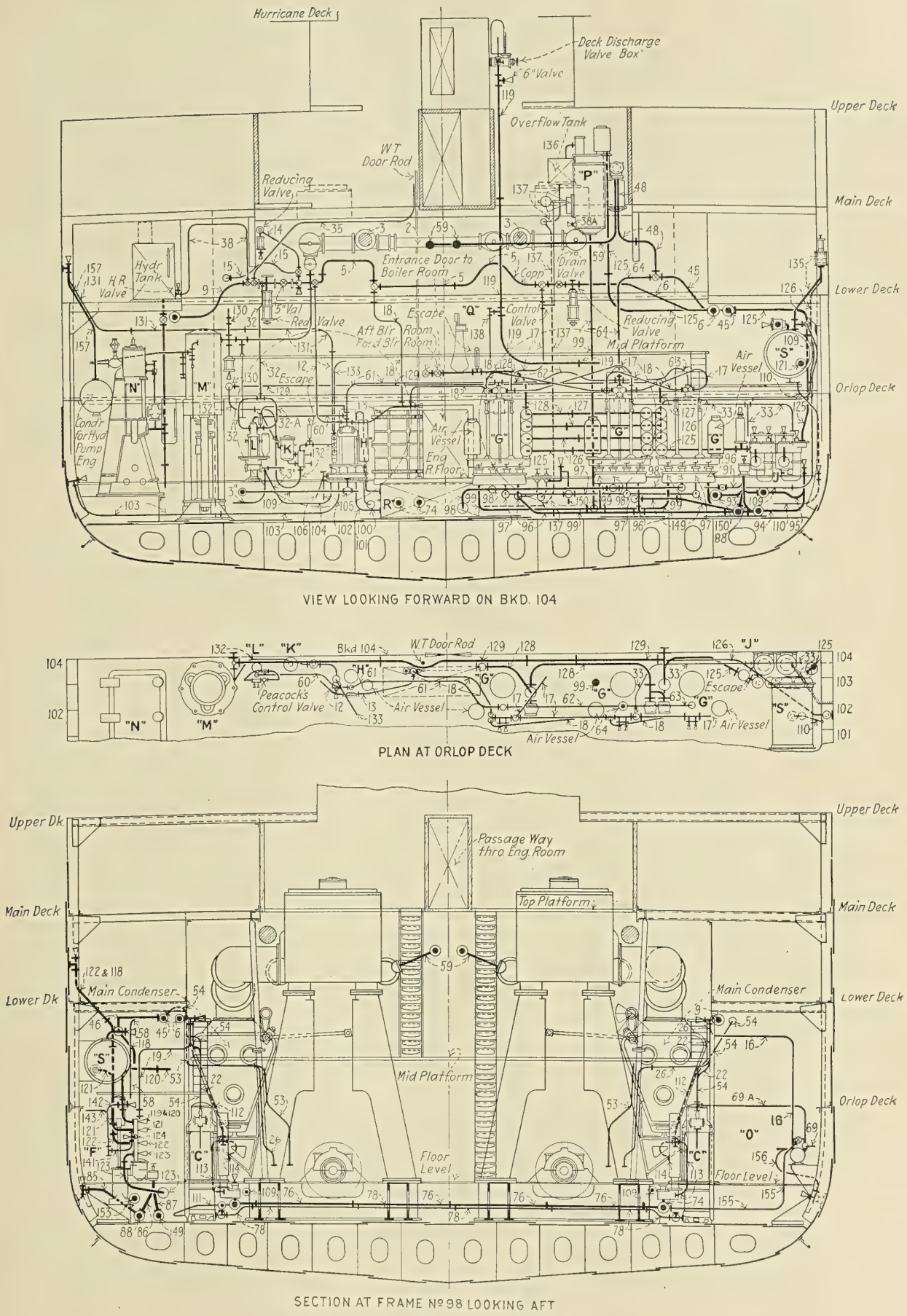


Fig. 10.—Sections Through Engine Room, S. S. *Naldera*

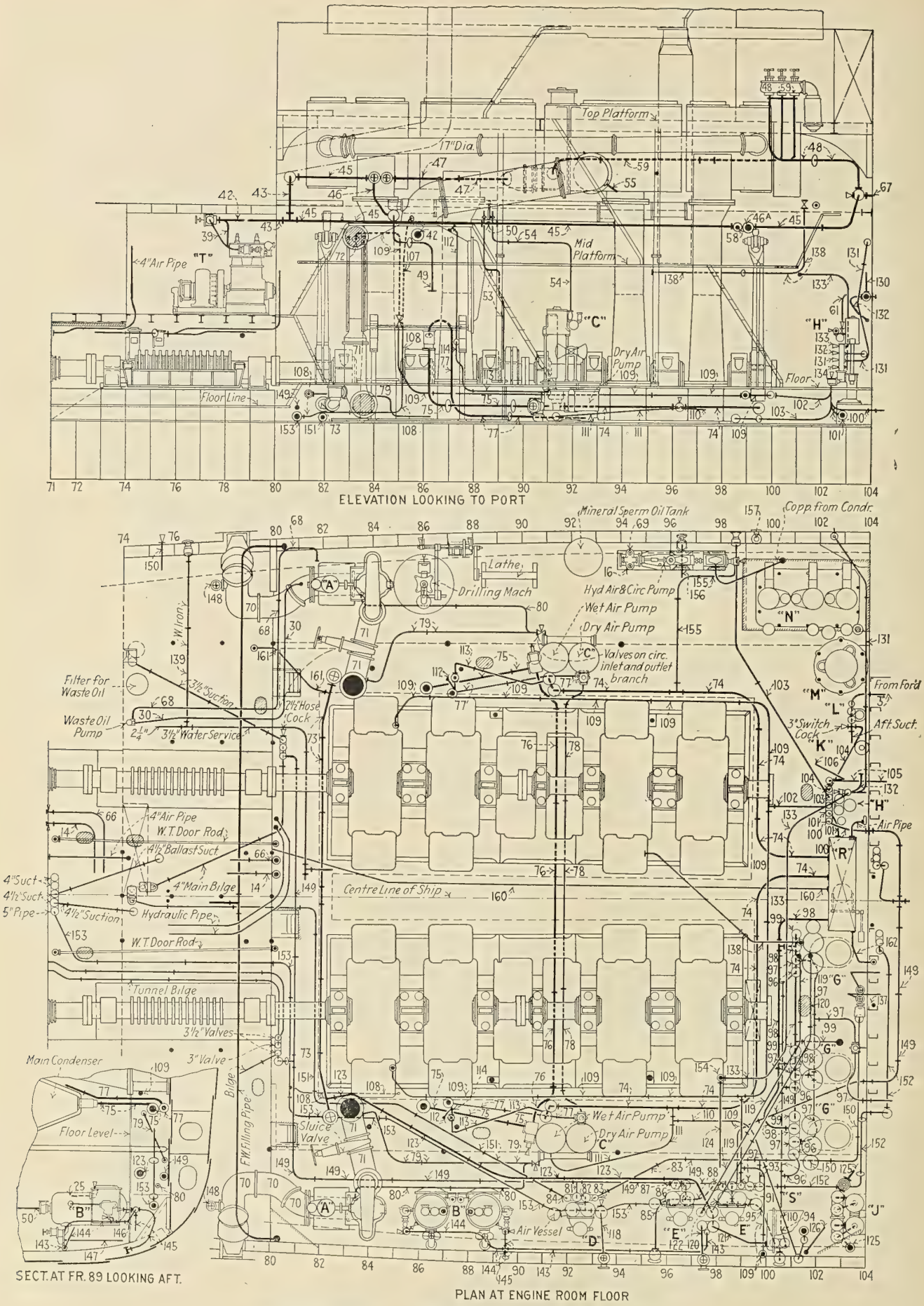


Fig. 11.—Machinery and Piping Arrangement, S. S. *Naldera*

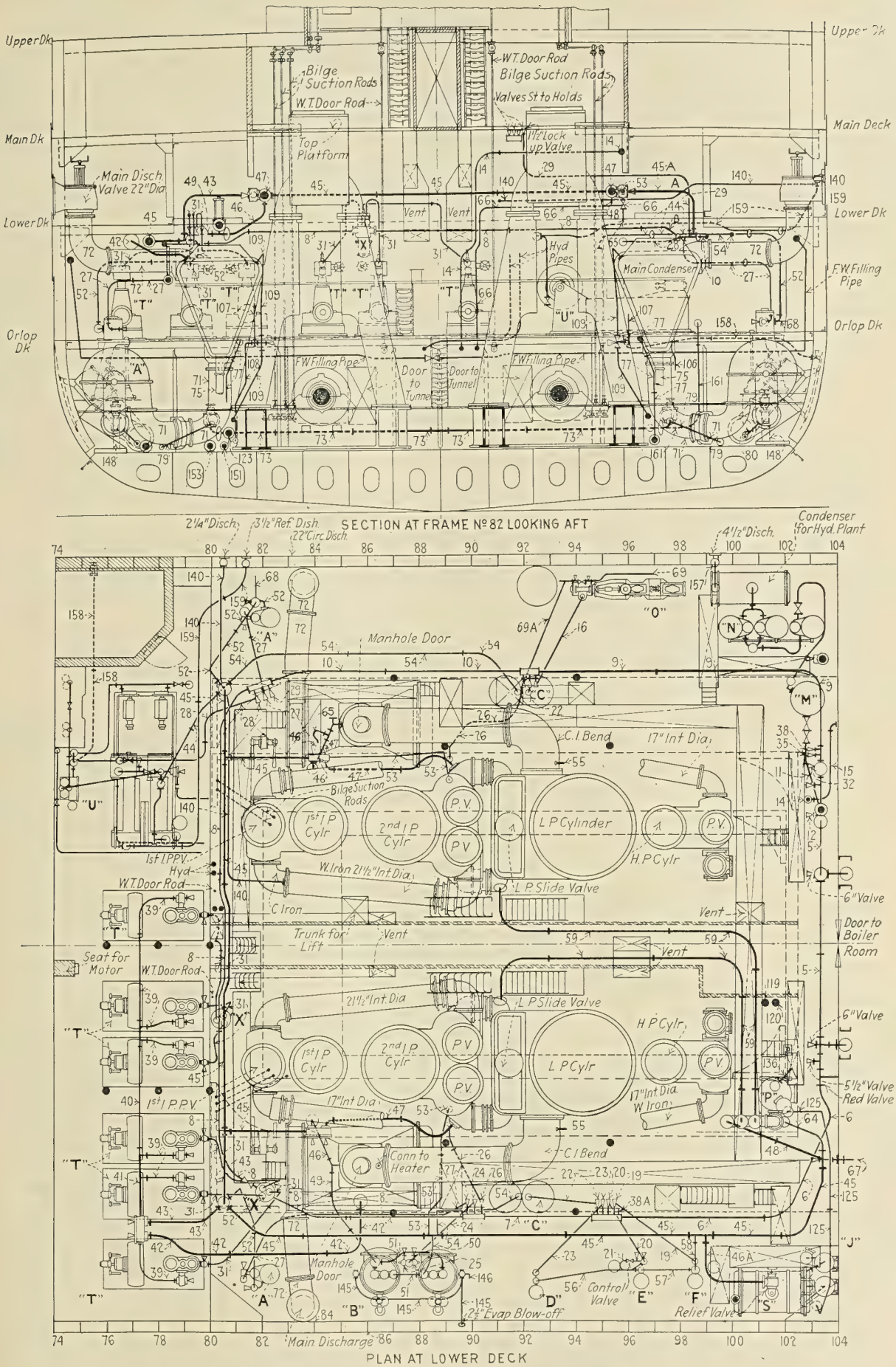


Fig. 12.—Machinery and Piping Arrangement

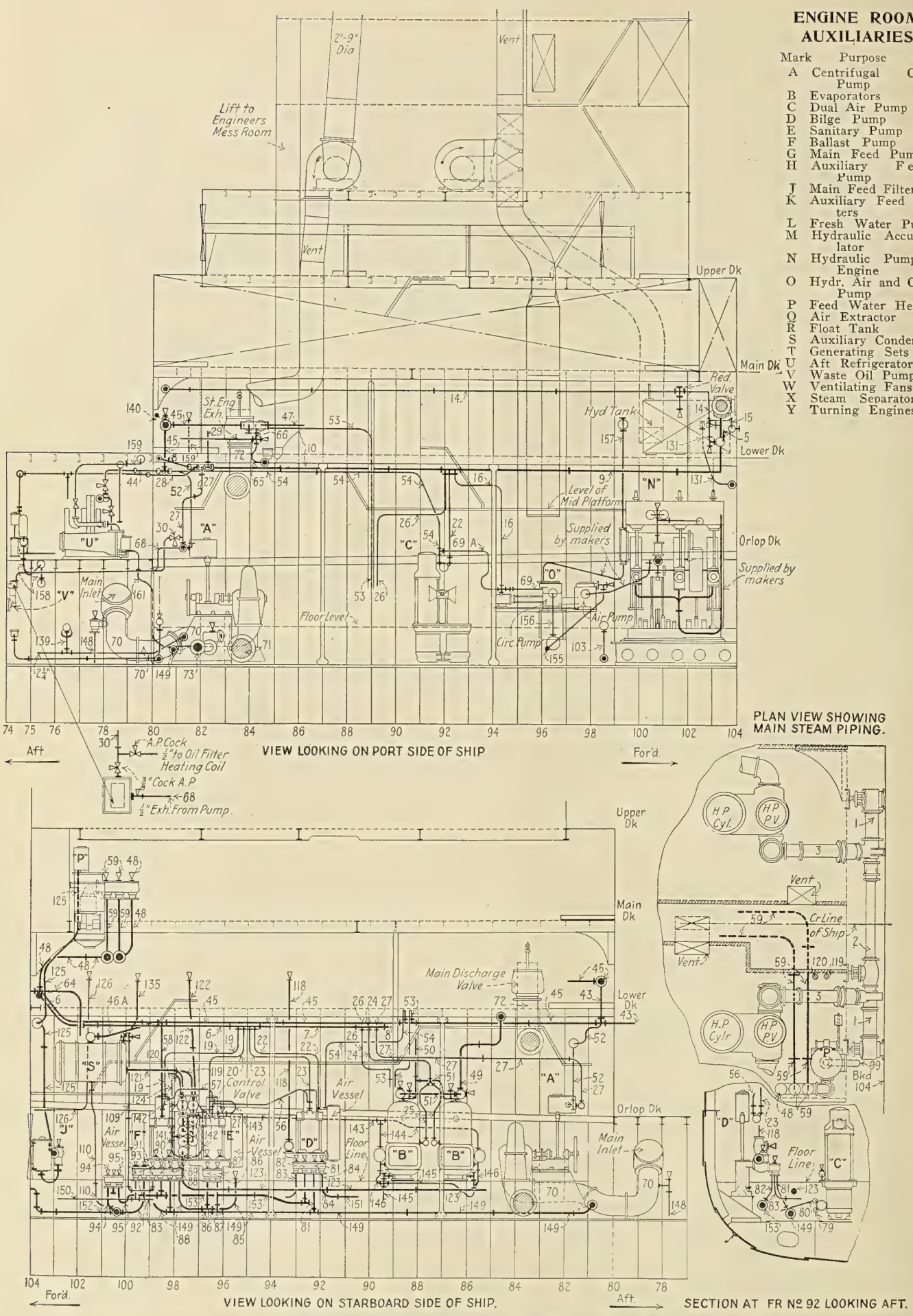


Fig. 13.—Outboard Longitudinal Sections of Engine Room, S. S. *Naldera*

Normal Manning Requirements of United States Shipping Board Vessels

Single Screw Average Speed Coal and Oil Burning Cargo Ships.

DECK DEPARTMENT

Rank	Coal Burning Vessels									Oil Burning Vessels								
D.W.T. / I.H.P.	3000 / 1000	4000 / 1250	5000 / 1500	6000 / 1750	7000 / 2000	8000 / 2250	9000 / 2500	10000 / 2750	11000 / 3000	3000 / 1000	4000 / 1250	5000 / 1500	6000 / 1750	7000 / 2000	8000 / 2250	9000 / 2500	10000 / 2750	11000 / 3000
Master	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Chief Officer	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2nd Officer	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3rd Officer	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Carpenter	—	—	—	1	1	1	1	1	1	—	—	—	1	1	1	1	1	1
Bosun	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Quartermaster	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
A. B. Seaman	6	6	6	7	7	7	8	8	8	6	6	6	7	7	7	8	8	8
Ordinary Seaman	2	2	2	3	3	3	4	4	4	2	2	2	3	3	3	4	4	4
Total	13	13	13	16	16	16	18	18	18	13	13	13	16	16	16	18	18	18

Note: All wooden steamers to carry carpenters.

ENGINE DEPARTMENT

Chief Engineer	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1st Asst	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2nd Asst	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3rd Asst	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Deck Engineer	—	—	—	1	1	1	1	1	1	—	—	—	1	1	1	1	1	1
Water Tender	—	—	—	—	—	—	—	3	3	—	—	—	—	—	—	—	3	3
Store Keepers	—	—	—	—	—	1	1	1	1	—	—	—	—	—	—	—	1	1
Oilers	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Firemen	3	6	6	6	6	9	9	9	9	3	3	3	3	3	3	3	3	3
Coal Passers	3	3	3	3	3	6	6	6	6	—	—	—	—	—	—	—	—	—
Wipers	—	—	—	—	—	—	—	—	—	2	2	2	2	2	3	3	3	3
Total	13	16	16	17	17	24	24	27	27	12	12	12	13	13	14	14	18	18

Note: All vessels with two or more W. T. Boilers to carry three water tenders. Fire room crew to be regulated by position of boilers. Forced or natural draft, number of fires and arrangement of bunkers.

Total Personnel Deck and Engine Depts.	26	29	29	33	33	40	42	45	45	25	25	25	29	29	30	32	36	36

STEWARD'S DEPARTMENT.

Personnel based on deck and engine complement.

Chief Steward	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Chief Cook	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2nd Cook and Baker	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Utilityman	—	—	—	1	1	1	1	1	1	—	—	—	—	—	—	1	1	1
Messmen	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Messboys	1	1	1	1	1	2	2	2	2	1	1	1	1	1	1	1	1	1
Total	6	6	6	7	7	8	8	8	8	6	6	6	6	6	6	7	7	7
Total Crew	32	35	35	40	40	48	50	53	53	31	31	31	35	35	36	39	43	43

Should vessel require more men in Steward's Department on account of arrangement—before adding to crew, matter to be taken up with United States Shipping Board's Port Steward.

Cable Steamer All America

Twin-Screw Cable Laying and Repairing Vessel Under Construction in England for the All America Cables, Inc.

THE cable steamer *All America,* a duplicate of the steamer *Guardian* owned by the Central & South America Telegraph Company, is now under construction at the Neptune Works of Swan, Hunter & Wigham Richardson, Ltd., Walker-on-Tyne, England, for the All America Cables, Inc., New York.

The *All America* is a twin screw cable laying and repairing steamer, built under Lloyd's special survey to class 100 A-1 and arranged to conform to the requirements of the American Bureau of Shipping.

Her characteristics are as follows:

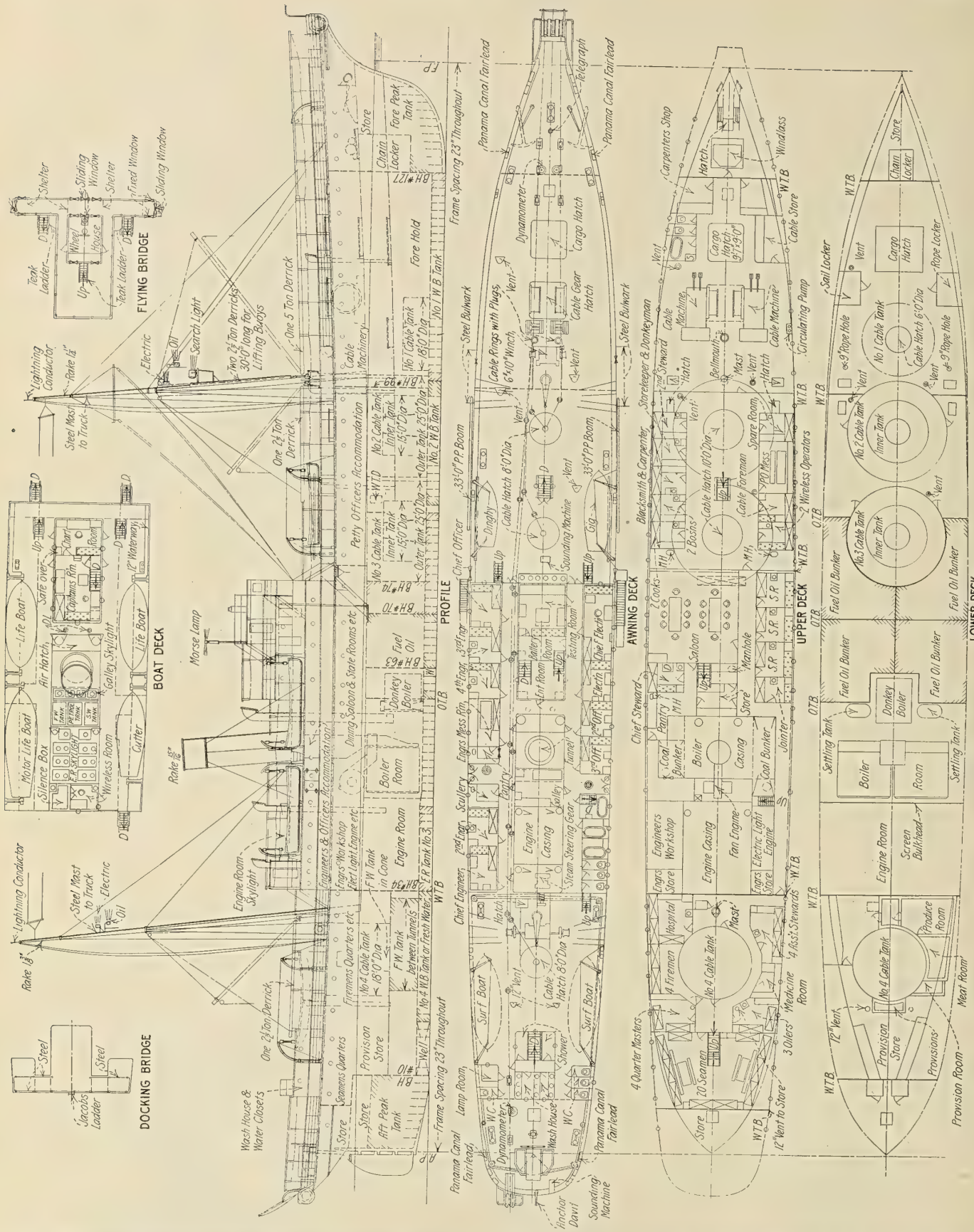
Length overall	295 feet 0 inches
Length between perpendiculars	270 feet 0 inches
Beam, molded	37 feet 0 inches
Depth, molded, to awning deck	24 feet 9 inches
Speed, knots	11
Designed mean draft	18 feet 0 inches
Deadweight capacity at 18-foot draft	1,750 tons
Maximum draft, summer freeboard	20 feet 0 inches

The vessel has four cable tanks, three forward and one aft. All these tanks have steel cones and the two largest tanks have inner tanks. The total coiling capacity of the cable tanks is about 14,000 cubic feet. The cable machinery, which is being supplied by the Telegraph Construction & Maintenance Company, of London, is of their latest and most improved pattern. There are three bow sheaves forward and one aft, and the necessary deck leads, dynamometers, telegraphs, etc.

A large testing room and battery room are provided on the awning deck, and there are also workshops and suitable arrangements for storing the buoys and special appliances used in cable repairing work.

The accommodation for the telegraph and cable staff is very complete. The accommodation for the captain, ship's officers and engineers and crew is also of a superior type.

The propelling machinery consists of two triple expansion engines with cylinders having diameters of 15½ inches, 25 inches and 43 inches by 30 inches stroke. Steam is supplied



General Arrangement Plans of the Cable Laying and Repairing Steamer *All America*

by two oil burning Scotch boilers, 13 feet 3 inches diameter by 11 feet 6 inches long, at 180 pounds pressure. The boilers are fitted with Howden's system of forced draft. A donkey boiler is fitted for auxiliary steam. The bunkers have a capacity of about 500 tons of fuel oil.

The auxiliary machinery includes one steam driven and one oil driven electric light and power generating set, refrigerating machinery, Lucas sounding machine, two steam winches, steam windlass, steam steering gear and a radio set having a day range of 200 miles.

The vessel's equipment includes a motor lifeboat, two steel lifeboats and working boats suitable for the vessel's service.

The *All America* will begin her career under the command of Captain Taylor, who for several years commanded the *Guardian* and has had considerable experience in cable laying and repair work.

Fig. 1.—*Clemson* Type Destroyer at Full Speed

Successful Performance of Recent Destroyers

Vessels of the Clemson Class, Driven by Westinghouse Cross-Compound Geared Turbines, Give Excellent Results on Official Trials

AT the outbreak of the war the United States had about forty serviceable destroyers in commission, but as the vital importance of these vessels was immediately established, this country began building them in large numbers, so that when the armistice was signed there were about 350 of this type in service and under construction.

There was also a marked increase in their dimensions. The typical destroyers of 1914 had a length of about 300 feet, a beam of 26 feet, a displacement of 900 tons, a speed of 30 knots and a horsepower of around 15,000. These vessels rendered an excellent account of themselves on both sides of the Atlantic during the war, but the need for greater seaworthiness and higher speed was plainly seen. Every new class authorized, therefore, had greater size and speed, until the last class, authorized in October, 1917, was given a length of 310 feet, a beam of 31 feet, a full load displacement of 1,308 tons, a speed of 35 knots and a horsepower of 28,000.

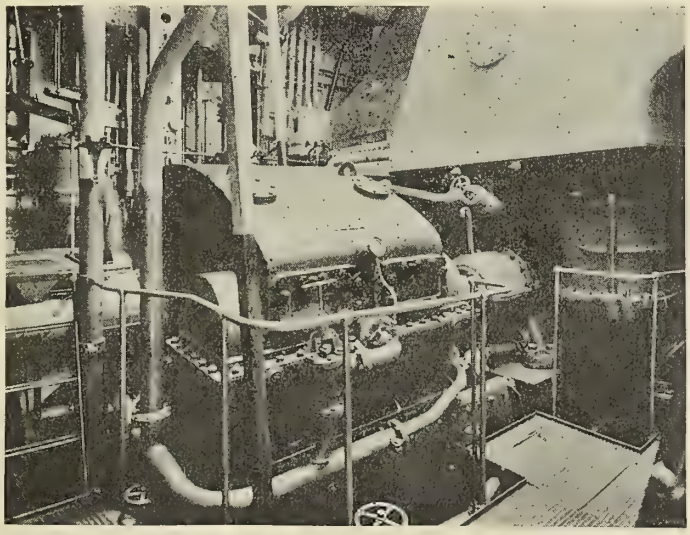


Fig. 2.—Gears and Turbines

Twenty-seven of this last class, known as the *Clemson* class, are now completed, fourteen having been built by the Newport News Ship Building & Dry Dock Company and thirteen by the New York Ship Building Corporation, with seven more to come from the latter builder.

The motive power of each of these vessels consists of two Westinghouse cross-compound geared turbines

Fig. 3.—Destroyers Under Construction at Yard of New York Shipbuilding Corporation, Camden, N. J.

rated at 14,000 horsepower each. This machinery has been so carefully designed to occupy the limited room available that it, together with all auxiliaries, takes up only 1,550 square feet of space and represents probably the maximum concentration of power to be found in any engine room.

Each turbine consists of a high pressure and a low pressure element, which drive a propeller through a common floating frame reduction gear. Either element can be used independently so that the ship is not completely crippled if even three of the four elements are out of commission. An astern turbine is incorporated in each low pressure element, and a cruising turbine, to give economical speeds of 15 knots or less, in each high pressure element.

The first of this class to go on trial was the *Clemson.* On her first trip her gears were found to be too noisy, but this was readily corrected, and on the official trials of all of the

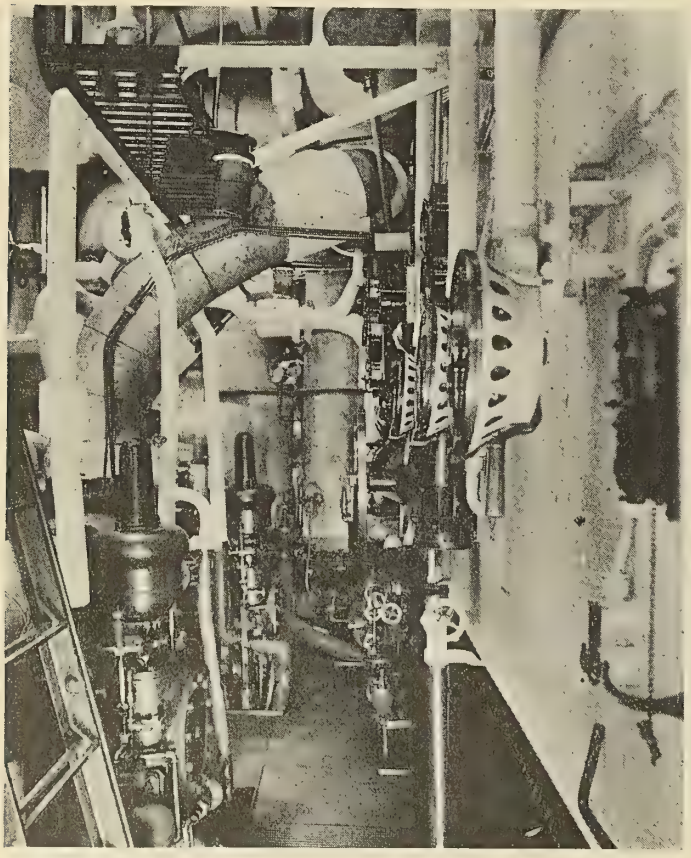


Fig. 4.—Control Platform

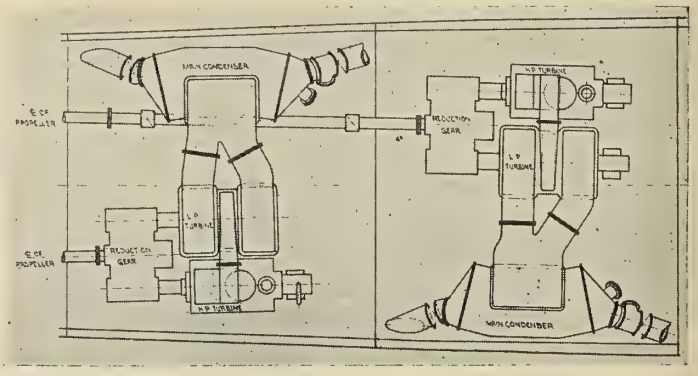


Fig. 5.—Machinery Arrangement of *Clemson* Type Destroyer

succeeding twenty-six boats the operation of the machinery proved to be so satisfactory that none has had to be repeated.

The fifth boat delivered by the Newport News yard, the *Satterlee,* was taken to Rockland, Me., for official standardization trials. She distinguished herself by making an average of 37.17 knots on her five high speed runs, at 486 revolutions per minute and 1,230 tons displacement, with a maximum speed of 38.26 knots, which constitutes the fastest official run ever made by a vessel of the United States Navy. She also broke another record by developing 31,223 shaft horsepower with her turbines. Later reports from the *Satterlee* state that "she is not afraid of any other ship running away from her."

The second vessel from the yards of the New York Shipbuilding Corporation, the *Brooks,* was likewise thoroughly tested at Rockland and showed excellent speeds and fuel economies.

Passenger and Cargo Steamship Hawkeye State

(*Continued from page* 194.)

lubrication are provided with ample oil supply and discharge channels with nozzles at the main turbine bearing pedestals and reduction gear frames. The supply nozzles are fitted with pressure gages and the discharge nozzles have sight flow indicators and thermometers.

The turbine glands are sealed with the steam leakoff from the inlet head high pressure turbine gland. This sealing steam pressure is controlled by valves at each of the sealed glands and by valve connection to both the low pressure turbine chest and exhaust. If this leakoff proves insufficient, steam is admitted to the sealing line from the auxiliary exhaust. All turbine glands and casings are drained through valves to the low pressure exhaust casing from where the water is removed by a vacuum trap.

Boilers

There are eight watertube boilers of the Yarrow type, built by the Bethlehem Shipbuilding Corporation, Ltd., at their Fore River Plant, Quincy, Mass., while the mechanical fuel oil burners were manufactured at the Redington Plant. These boilers have a total heating surface of 40,000 square feet and are built for a working pressure of 265 pounds per square inch. Foster superheaters will give 75 degrees superheat at nominal full power.

The boilers work under forced draft, using the closed stokehold system. Airlocks are provided between the two firerooms, between the after fireroom and engine room and to the escape trunks, which extend to the upper deck. Vertical sliding watertight doors are located in the first two of the above airlocks, and operate from the upper deck.

Trials

The sea trials were conducted on January 17, over a measured mile off the Delaware Breakwater. The ship was at a mean draft of 24 feet and displaced about 16,070 tons.

The tabulated result of the three trials follows, the water rate of the turbines being referred to a uniform standard of 250 pounds pressure per square inch at the turbines, 75 degrees superheat and 28-inch vacuum:

	One-Half Power	Three-Quarters Power	Full Power
Duration of trial, hours	6	6	12
Revolutions per minute	102	111	125
Speed in knots	15.5	16.8	18.8
Shaft horsepower	7,110	9,930	13,000
Water rate of turbines, pounds	11.40	10.64	9.98
Boiler pressure, pounds per square inch	260	260	261
Pressure at high pressure turbine chests	247	244	238
Pressure at low pressure turbine chests	2.1	1.1	5.6
Vacuum, inches	29.13	28.8	28.64

There was an entire absence of noise and vibration at all speeds, and outside of the engine room it was impossible to tell whether or not the engines were running. Such a performance promises well for the comfort of the passengers and speaks well for the builders of hull and machinery.

It is believed that the speed obtained makes this the fastest ocean steamship built since the war, and the 13,200 shaft horsepower obtained makes this the most powerful geared turbine outfit yet installed on a commercial vessel in the United States. It is also believed that the model is one of the best, if not the most efficient in the passenger service.

A feature of particular interest in connection with the *Hawkeye State* and her sister ships building at Sparrow's Point is, that, although the ship was not built entirely at one plant, it was, to an unusual degree, the product of one corporation. All of the five eastern plants of the Bethlehem Shipbuilding Corporation, Ltd., contributed certain manufactured parts in which the particular plant specialized. This, indeed, is the "Bethlehem" practice on all contracts.

On this ship, parts were contributed by other plants than Sparrow's Point somewhat as follows:

The Fore River Plant at Quincy, Mass., made the turbines, boilers, and ventilator cowls.

The winches, windlass, gypsies, steering engine and telemotor fittings are of the regular Bethlehem-Moore design and manufacture, being made at the Moore Plant, Elizabeth, N. J., which plant also furnished a large part of the iron castings.

The Harlan Plant at Wilmington, Del., furnished the boats, hinged watertight doors, portable stateroom furniture and tables and buffets in main dining saloon.

The Redington Plant at Redington, Pa., made the rectangular airports in the public rooms on the bridge and boat decks, and the fuel oil burners.

In addition to all structural work and built-in joiner work, the Sparrow's Point Plant made most of the forgings and a large part of the brass castings.

The Bethlehem Steel Company contributed structural material, drop forgings and iron and steel castings from several of its plants.

It is, therefore, evident that, to an unusual degree, full advantage has been taken of the vast and varied "Bethlehem" resources in producing a ship which might be justly termed the last word in American shipbuilding practice.

To Compute Cargo Space

The United States Bureau of Standards has worked out, for the use of shippers, the following formula for computing the hold space required for a shipment of barrels, when the internal contents in cubic feet are known:

$$V = \frac{2.81}{2 - \frac{1}{L} - \frac{1}{W}} \times v \times N,$$

where

V = total hold space required.
v = internal contents in cubic feet.
1 gallon = 0.134 cubic feet
L = number of barrels in length of bottom layer.
W = number of barrels in width of bottom layer.
N = number of barrels in shipment.

The coefficient

$$\frac{2.81}{2 - \frac{1}{L} - \frac{1}{W}}$$

varies with the shape and size of hold. For existing commercial conditions the range of variation of the coefficient is in all probability between 1.5 and 1.8.

Assume a shipment of 134 fifty-gallon barrels, the bottom layer 10 barrels long and 4 barrels wide; then

L = 10.
W = 4.
v = 50 × 0.134 cubic feet.
= 6.7 cubic feet.
N = 134 barrels.

Substituting in the formula

$$V = \frac{2.81}{2 - \frac{1}{10} - \frac{1}{4}} \times 6.7 \times 134$$

= 1.7 × 6.7 × 134.
= 1,526 cubic feet of hold space required.

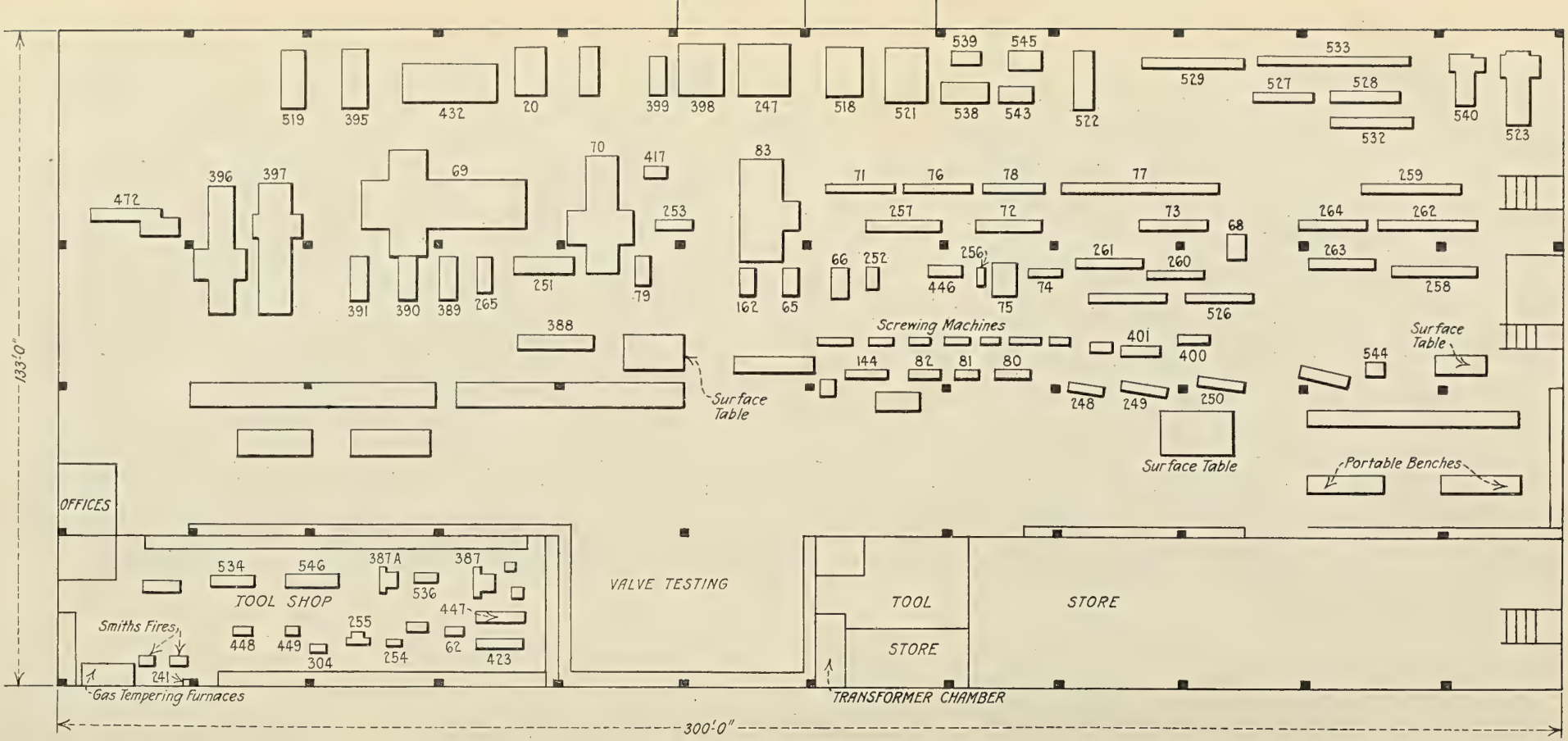


Fig. 17.—Layout of Fitting Shop

Fitting Shop

MACHINES

Key No. Description and Size

20 Bandsaw and 6½ H. P. motor.
62 Cincinnati milling mach.
65 Radial drill, 42".
66 Radial drill, 42".
67 Capstan lathe.
68 Milling mach.
69 Motor-driven planer, 7' x 5'-6" x 14'.
70 Planer, 4' x 3'-6" x 10'.
71 Lathe, 8" x 12'-6" bed.
72 Center lathe, 10½".
73 Center lathe, 10½".
74 Surfacing and boring lathe, 30".
75 Shaping mach., 26" stroke.
76 Four-jaw chuck lathe, 8".
77 Lathe, 10" x 30'-6" bed.
78 Four-jaw chuck lathe, 10" x 12'-6" bed.
79 Patent slotting mach., 12" stroke.
80 Bolt screwing mach.
81 Double bolt cutter, 1¼".
82 Double bolt cutter, 1¼".
83 Worm-driven horiz. boring and facing mach.
107 Patent screwing mach.
144 Nut tapping mach.
162 Grindstone.
241 Centrifugal fan.
247 Horiz. drilling and tapping mach.
248 Hexagonal turret lathe.
249 Capstan lathe.
250 Capstan lathe.
251 Radial drilling mach., 5'-6".
252 Single spindle drilling machine.
253 Radial drill, 4'-2".
254 Twist drill grinding mach.
255 Univ. grinding mach.
256 Key seating mach.
257 Center lathe, 10½".
258 Center lathe, 8½".
259 Center lathe, 8½".
260 Center lathe, 6½".
261 Center lathe, 6½".
262 Center lathe, 10½".
263 Center lathe, 8½".
264 Center lathe, 8½".
265 Slotting mach., 12".
274 2 smiths' fires.
275 Surface plate, 6'-0" x 4'-0".
304 Wet tool grinder, 12".
375 Port. milling mach.
384 Screwing mach.
385 Screwing mach.
386 Cincinnati vert. milling mach.
387 Cincinnati univ. milling mach.
387A Cincinnati univ. milling mach.
388 Radial drilling, boring and studding mach., 6'-0" radius.
389 Radial drilling, boring, tapping and studding mach., 4'-6" rad.
390 Radial drilling, boring, tapping and studding mach., 4'-6" rad.
391 Radial drilling, boring, tapping and studding mach., 4'-6" rad.
392 Radial drilling, boring, tapping and studding mach., 4'-6" rad.
393 Radial drilling, boring, tapping and studding mach., 4'-6" rad.
394 Patent slotting mach., 12" stroke.
395 Slotting mach., 24" stroke.
396 Planning mach., to place 4'-0" x 42" high; 10'-0". long.
397 Planing mach., to plane 4'-0" x 42" high; 10'-0" long.
398 Boring and facing mach.
399 Band sawing mach.
400 Capstan lathe.
401 Capstan lathe.
417 Pipe flange facing mach.
423 Hollow spindle lathe, 7".
429 Twin-chambered furnace with blower.
432 Surfacing and boring mach.
433 Gun ring mach.
445 Radial drill, 5'-0".
446 Radial drill, 5'-0"
447 Lathe, 7".
448 Sensitive drill.
449 Drill grinder.
450 Univ. grinder.
472 Surfacing and boring mach.
518 Boring and tapping mach.
519 Slotting mach.
520 Lathe.
521 Boring and facing mach.
522 Radial drill, 6'-0".
523 Planing mach., 10'-0".
526 Lathe, 10".
527 Lathe, 10".
528 Lathe, 10".
529 Lathe, 13".
530 Lathe, 10".
531 Lathe, 8".
532 Lathe, 8".
533 Lathe, 12".
534 Lathe, 8".
535 Turret lathe.
536 Lathe, 7".
538 Slotter, 13".
539 Slotting mach., 7".
540 Planer, 6'-2" x 2'-5".
541 Radial drill, 5'-0".
542 Radial drill, 3'-0".
543 Radial drill, 5'-0".
544 Sensitive drill.
545 Vert. drill.
546 Vert. milling mach.
562 Oscillating tool grinder.
563 Plain grinder.
601 Gun ring mach. (graduating).
606 Peter's abrasive cutting-off mach.

CRANES

84 10-ton crane (span 40'-9"); hoist, 10 tons 15 F. P. M.; cross travel, 100 F. P. M.; long travel, 300 F. P. M.
85 10-ton crane (span 25'-9"); hoist, 10 tons, 15 F. P. M.; cross travel, 75 F. P. M.; long travel, 300 F. P. M.

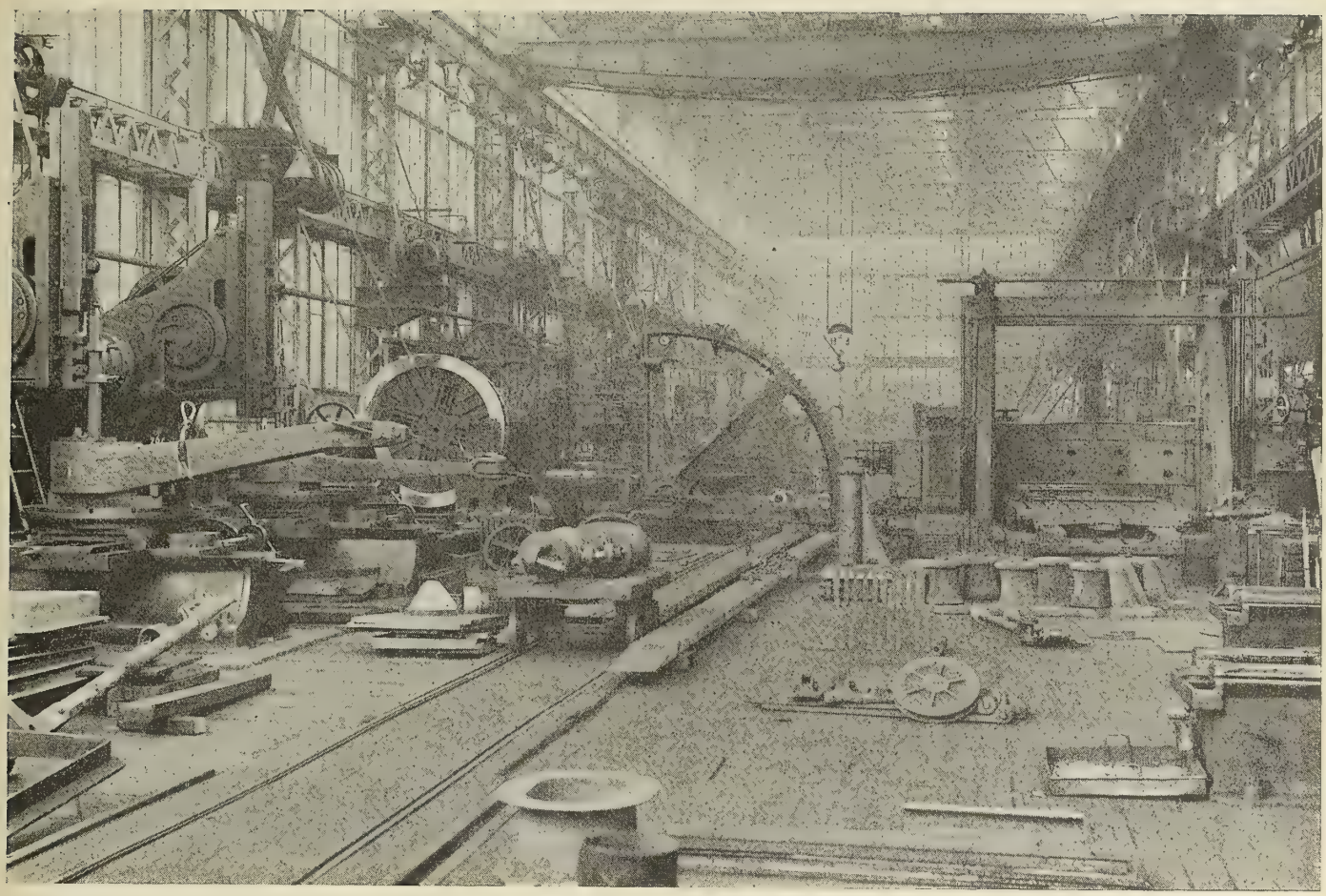


Fig. 18.—Fitting Shop—View of South Bay

One of England's Largest Shipyards—II

Continuation of Description of Plant of the Sir W. G. Armstrong, Whitworth and Company, Limited, at Newcastle-on-Tyne

IN the preceding issue of this magazine the general layout of plant and the structural shops of the Armstrong yard of the Sir W. G. Armstrong, Whitworth & Company, Limited, were described in considerable detail. The following is a continuation of the above and describes in detail the remaining shops which make up this prominent addition to the merchant shipbuilding resources of England.

Fitting Shop

The fitting shop is a steel framed structure similar in character to those already described. It is 300 feet long by 133 feet wide and is divided into four bays; that on the southern side has a clear width of 44 feet, while the two central bays are each 28 feet wide and the bay on the northern side is 29 feet wide. An upper floor extends over two of the bays along the northern side, providing accommodation for the sailmakers, model makers and riggers. The sail loft is equipped with power driven sewing machines for dealing with canvas work of all descriptions.

The fitting shop is particularly well equipped with heavy tools originally intended for warship work. Although these may not all be so fully employed now that the yard is engaged in merchant shipbuilding, it is a distinct advantage to have them available for use at any time. From Fig. 17 it will be noted that the tools are all arranged in the two bays on the south side of the shop and each is provided with a 10-ton electric overhead traveling crane.

Tool Equipment

The tool equipment includes a number of modern lathes, turret lathes, nut tapping machines and bolt screwing machines. There are also surface, boring and facing machines specially designed for boring "A" brackets for vessels of moderate size and some 42-inch sensitive radial drills which are largely employed for drilling and tapping holes for the ¼-inch screws used with metal strips for securing India rubber gaskets on watertight doors. There are a number of radial drills, shaping machines and slotting machines. Figs. 18 and 19 show views of the central and south bays of the fitting shop, and on the right in Fig. 18 is shown a planing machine which is the only tool in the shop calling for special comment.

This machine was specially designed for transverse as well as longitudinal planing and is a particularly convenient tool for working on watertight doors, etc. It can accommodate work up to 14 feet long by 7 feet wide by 5 feet 6 inches deep and is driven by electric equipment giving longitudinal cutting speeds ranging from 18 feet to 72 feet per minute, with a quick return of from 100 feet to 150 feet per minute. The transverse cutting speeds are two-thirds of the longitudinal speeds. The change over from longitudinal to transverse planing is effected by means of a mechanically operated clutch, the time taken for the operation being, of course, only a very small fraction of the time which would be occupied in resetting the work. Both the bed and table are specially de-

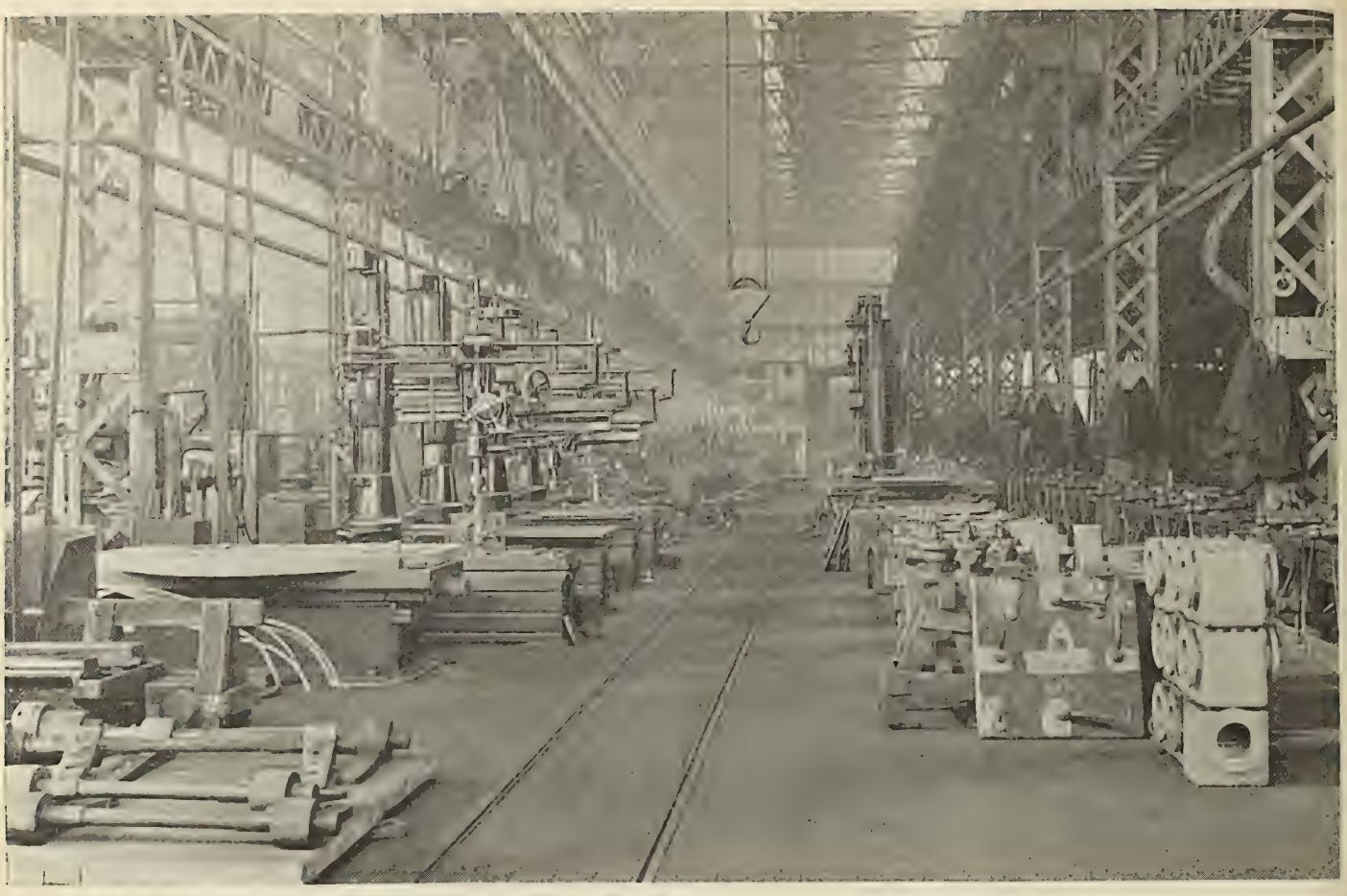


Fig. 19.—Fitting Shop—View of Center Bay

Fig. 20.—Blacksmith Shop

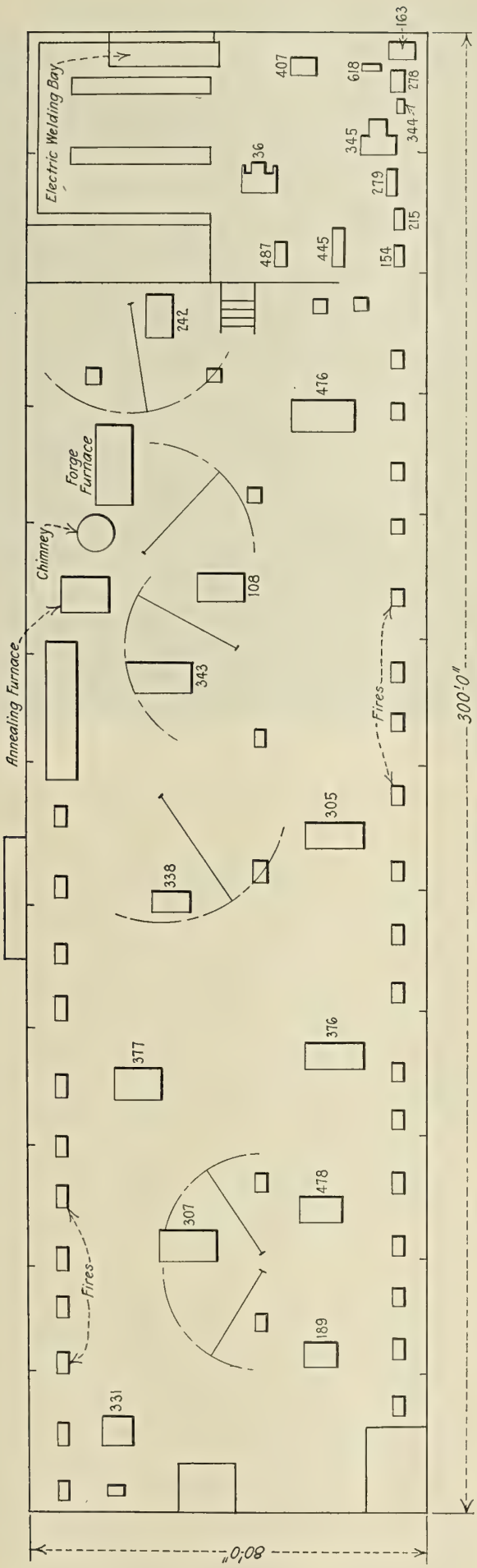


Fig. 21.—Layout of Blacksmiths' Shop

Blacksmith Shop

MACHINES

Key No.	Description and Size
36	Punch, shears and notcher.
108	Pneumatic hammer, 40 cwt.
123	Smiths' fires with four high pressure motor-driven fans (6½ horsepower motors).
189	Pneumatic hammer, 5 cwt.
154	Plain grinder.
163	Grindstone.
188	High pressure motor-driven fan (6½-horsepower motor).
215	Drill.
242	Pneumatic hammer, 42" stroke; air inlet, 4" diameter; 15 cwt.
278	Plain grinder.
279	Radial drill.
305	Pneumatic hammer, 10 cwt.
307	Pneumatic hammer, 3 cwt.
331	Pneumatic hammer, 3 cwt.
338	Pneumatic hammer, 15 cwt.
343	Pneumatic hammer, 20 cwt.
344	Single grinder.
345	Vertical drill.
376	Pneumatic hammer, 10 cwt.
377	Pneumatic hammer, 15 cwt.
407	Band saw.
445	Capstan lathe.
476	Pneumatic hammer, 10 cwt.
478	Pneumatic hammer, 7½ cwt.
487	Radial drill.
618	Swing frame grinder.

Cranes

166	Hand crane, 3-ton, 21′ radius.
167	Hand crane, 3-ton, 21′ radius.
168	Hand Crane, 3-ton, 25′ radius.

signed for the reception of heavy work and the machine is arranged so that all operations, including the starting and stopping of the table, are controlled from the front. Safety switches are provided on both sides to prevent the possibility of overrunning of the table.

Another machine of the same type, but rather smaller and arranged for belt driving, is also provided.

Most of the machines in the shop are belt driven from line shafting carried on roller bearings, but some of the larger tools are provided with independent electric motors.

Tool Shop, Stores and Testing Departments

About half of the bay on the northern side of the shop is partitioned off to form a tool store and a store for finished parts and a portion of the space is utilized for the hydraulic testing of castings for valves, etc. The remainder of this bay is occupied by the tool shop in which the whole of the small tools, gages, etc., required in the yard are made, adjusted and repaired. This tool shop is equipped with gas-fired hardening and tempering furnaces, twist drill grinder, a universal grinder and an oscillating grinder which is used for making lathe and planer tools by grinding from the bar without forging.

For cutting up bars of high speed steel for making tools, a 10-inch carborundum wheel 1/10 inch in thickness and running at 4,600 revolutions per minute is employed. This has been found to effect a considerable saving in time on this work.

A gear planer for miter and bevel wheels is also installed in the shop, as well as a number of engraving machines. One of these machines is specially arranged for marking degrees on steering dials and other angular work of this character.

A graduating machine, specially designed by Messrs. Armstrong for engraving gun rings, is also installed in this shop.

For checking the dimensions of gages and of finished work, a large vernier caliper is used. This instrument is fitted with agate-faced jaws which can be adjusted by means of fine screws and is capable of reading up to 60 inches by thousandths; a microscope is provided for reading the vernier.

Blacksmith Shop

The blacksmiths' shop, which is situated between the angle racks and the fitting shop, occupies the greater part of a building which has a total length of 300 feet and a width of 80 feet. The actual dimensions of the blacksmiths' shop are

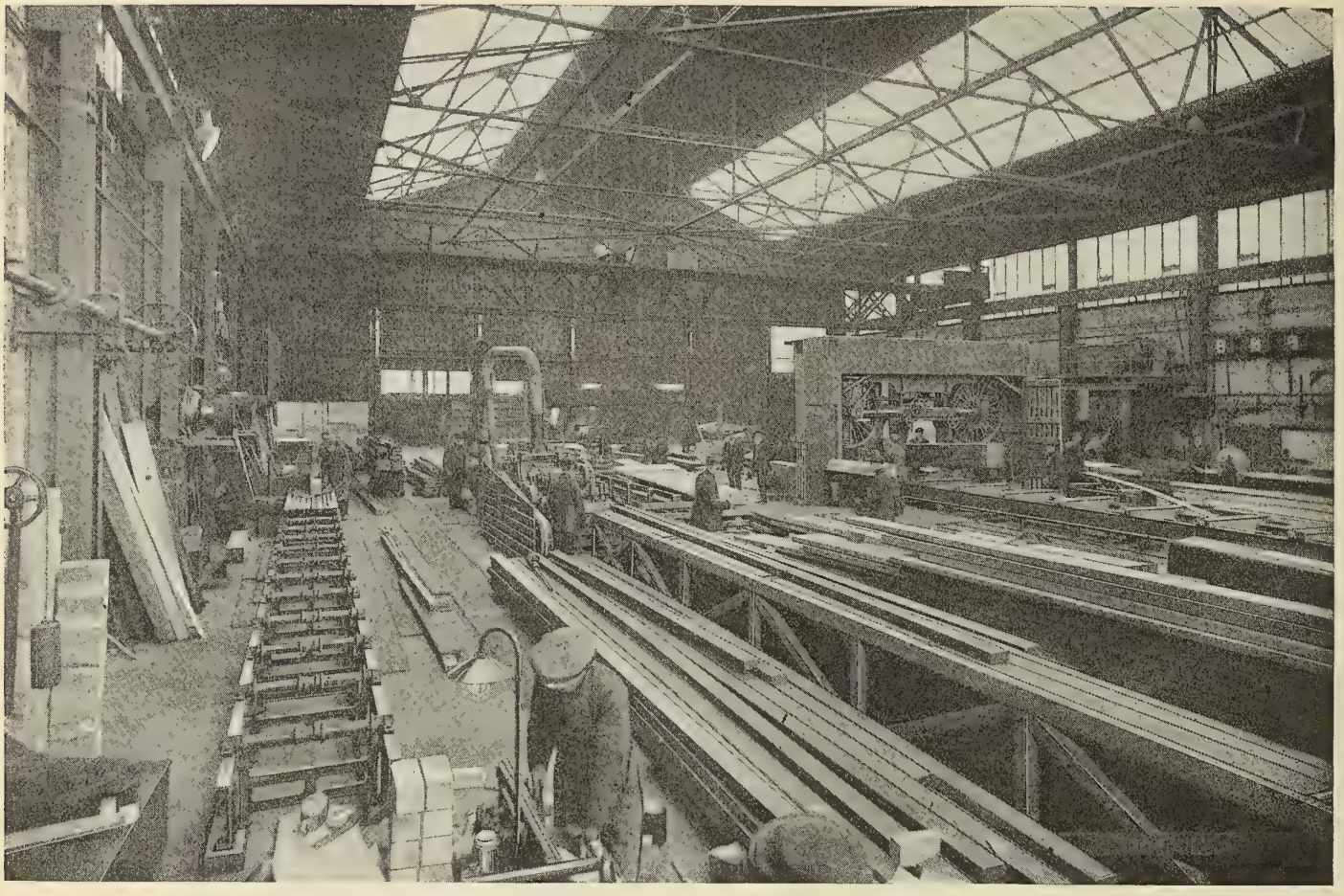


Fig. 22.—Saw Mill

250 feet long by 80 feet wide, the remaining portion of the building at the western end forming the blacksmiths' fitting shop.

Main Smiths' Shop

In the main smiths' shop, Figs. 20 and 21, fires are arranged along both sides of the building and a system of grouping similar to that described in connection with the anglesmiths' shop has been adopted.

The blast is supplied by four high pressure fans which deliver air at a pressure of 14 inches of water gage through galvanized steel pipes fitted with cast iron connections to the fires. The smoke from the fires is carried away by uptakes connected in convenient groups to funnels which are sufficiently high to provide a natural draft.

Practically the whole of the forgings and stampings required in the yard are produced in this shop, which is equipped with twelve power hammers. These range from 3 hundredweight to 2 tons in capacity, the smaller hammers being of the electro-pneumatic type, while the larger ones are worked by compressed air from the yard power station.

For heating heavy work a gas-fired regenerative furnace 6 feet 6 inches long by 4 feet wide is provided and there is also a smaller furnace for annealing the forgings. These furnaces, and also the larger hammers, are conveniently served by hand power cranes. Bogie rails are also laid to facilitate the handling of the work.

Blacksmiths' Fitting Shop

In the blacksmiths' fitting shop, above referred to, articles such as handrails, stanchions, ladders, gratings, etc., are made and the equipment includes a punching and shearing machine with notching attachment, a capstan lathe, a band saw and a number of drills and grinders of various types. One of the grinders is of the swinging frame type for surface work. Part of the shop is equipped with apparatus for electric and oxy-acetylene welding.

Woodworking Department

The woodworking department is accommodated in three buildings at the extreme northern end of the yard.

The saw mill is situated close to the fitting-out dock, the timber shed behind it and the joiners' and cabinet makers' shop on the southern side. The saw mill forms the central portion of a building having a total length of 175 feet and a width of 120 feet placed parallel to the dock. At the northern end of the building is a boat builders' shop which occupies a space measuring 120 feet by 71 feet; the saw mill measures 120 feet by 82 feet 6 inches and the greater part of the remaining portion, at the southern end, is utilized as a saw sharpeners' shop.

The only machine tools in the boat builders' shop are a saw bench and a drilling machine, most of the work in this shop being done by hand tools. Kilns are, however, provided outside the building, at the northern end, for steaming the planks preparatory to bending.

Saw Mill

The most notable appliance in the saw mill is a horizontal band saw for logs. This saw can deal with logs up to 4 feet square, and the timber carriage, as usually employed, is of sufficient length to accommodate logs up to 40 feet long. The carriage is made in two parts, which can be separated by 20 feet if necessary, and by this means logs up to 60 feet in length can be dealt with.

A circular saw bench with traveling table for logs and a heavy planing machine, which is largely used for planing deck planks, can deal with timber up to 16 inches by 8½ inches in section. Another planer to take work up to 30 inches by 9 inches and fitted with hand and power feed is in-

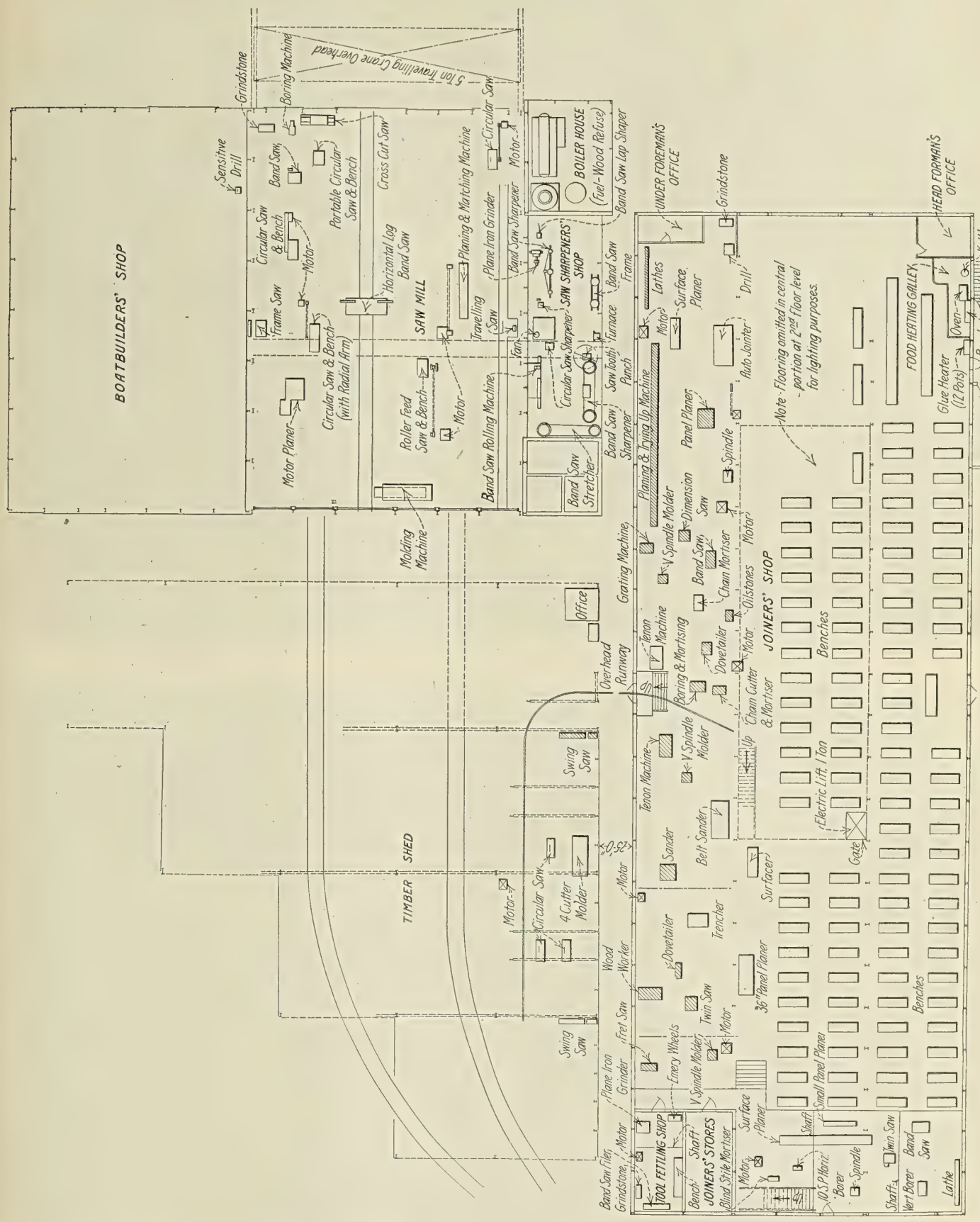


Fig. 23.—Plan of Joiner Shop, Saw Mill and Timber Shed

stalled and the equipment also includes a vertical log frame, a reciprocating cross cut saw, a band saw, two boring machines and a molding machine.

Dust and shavings are extracted by an exhaust fan which draws the dust-laden air from a pit to which the various machines are connected. The dust is used for firing a boiler which heats some of the adjacent shops.

The saw mill is served by a 5-ton overhead electric traveling crane of 80-foot span. The eastern end of the saw mill can be opened to full width to allow the crane to pass and the crane rails are extended on a gantry so that the crane can be run out over the dock to lift logs from railway trucks and to pick them up from the dock when delivered from barges on the river. The logs are taken into the saw mill by the over-

Fig. 24.—Plumbers' Shop, Pipe Bending Section

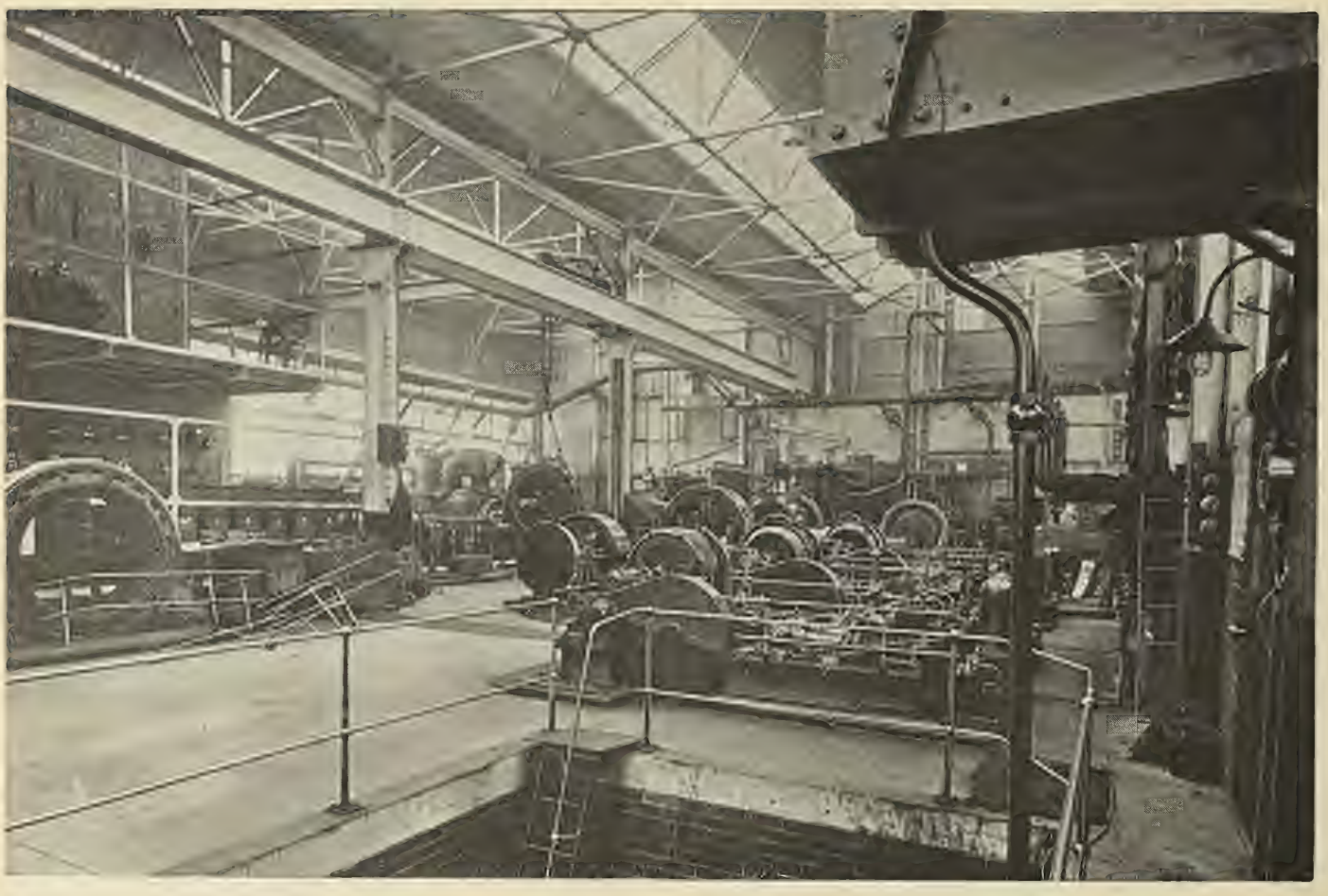
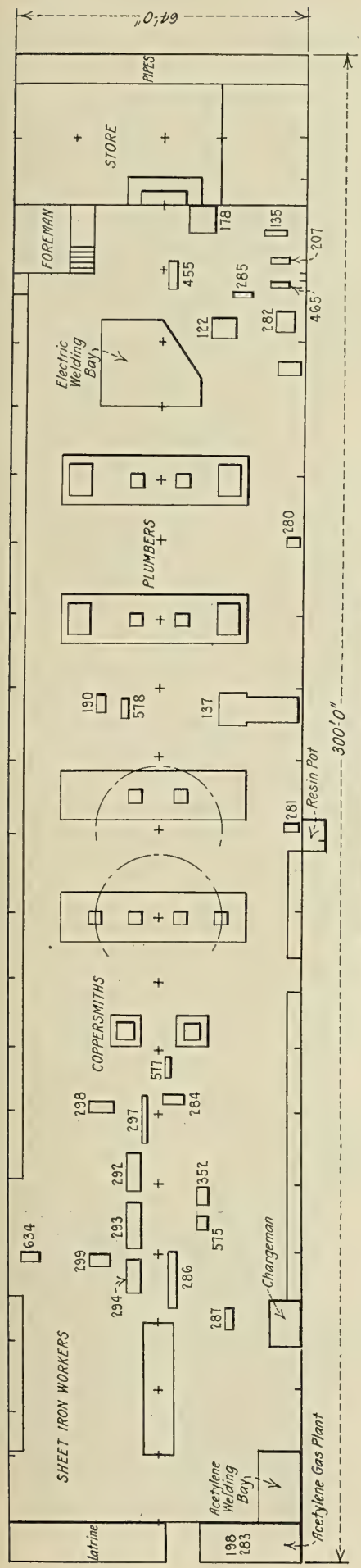


Fig. 25.—Power Station



Plumbers' Shop

MACHINES

Key No.	Description and Size
122	Tube sawing machine.
135	Screwing machine, ¾-inch to 4-inch pipes.
137	Hydraulic pipe bender, 18-inch stroke.
178	Horizontal drill.
190	Pipe filing machine.
198	Acetylene gas plant.
207	Screwing machine.
280	Blower.
281	Blower.
282	Grinder.
283	Acetylene gas plant.
284	Ball bearing drill.
285	Ball bearing drill.
286	Strong bender, 8'.
287	Two hand lever punches.
292	Power shears, 6' by 1/16".
293	Power shears, 8' by ⅛".
294	Multiple punch.
297	Plate bending rolls, 6'.
298	Hand lever cutting machines (four).
299	Punch and shears (hand).
352	Punch and shears, 12" gap.
455	Sensitive drill.
465	Screwing machine.
575	Power shears, 8' by ⅛".
576	Strong bender, 8'.
577	Tube sawing machine (for copper).
578	Pipe filling machine.
583	Pipe bender (hand), up to 2" diameter.
634	Pneumatic planishing hammer.
	Riveter.
	Hydraulic pipe flanger.
	Six plumbers' fires.
	Ten coppersmiths' fires.
	Bending slabs.
	Lathe, 6".
	Lathe, 9".
	Buffer.

Fig. 26.—General Arrangement of Plumbers' Shop

head crane and the sawn timber is afterwards transferred to separate seasoning kilns for hard and soft woods by means of bogie railways.

Timber Sheds

There are four timber sheds, each 43 feet in width and ranging in length from 158 feet to 60 feet. After treatment in the kilns the timber is transferred to air-drying racks and there stored until required for use. It is then cut to lengths by pendulum and circular saws provided in the sheds and conveyed by bogie trucks and overhead runways to the joiners' and cabinet makers' shop, in which the whole of the joinery work and furniture, including chairs, required for vessels built at the yard is constructed.

Joiner Shop

The joiner shop is a two-story building 300 feet long and 100 feet wide. It is divided into three bays, of which the central one is 40 feet wide and the two outer bays are each 30 feet in width. The upper flooring is omitted in the central portion of the shop so as to provide ample light on the ground floor.

The machine tools are all situated in the bay on one side, while the bay on the other side is occupied with benches. The central bay may be cleared for erecting the work.

Among the more notable machines in the shop are planing and trying-up machines capable of taking timber up to 18 inches square in section, a panel planer which can deal with work up to 36 inches by 7 inches, a three-drum sandpapering machine for work up to 40 inches by 4 inches, and a planing and molding machine, with friction feed, which takes work up to 12 inches by 4 inches in section.

Other tools which may be mentioned are a 24-inch by 6-inch tenoning machine, two vertical spindle molding machines and a hollow chisel and chain mortising machine, a number of circular saw benches and band saws and a 10-spindle boring machine. Most of the tools are belt driven from line shafting carried on roller bearings, but some of the larger machines have independent driving motors.

Furniture constructed on the ground floor is taken by means of an electric lift to the upper floor where it is polished or otherwise finished and stored until required. The upper floor is also arranged to accommodate additional tools and benches for joiners' and cabinet makers' work.

Plumbers' Shop

The plumbers' shop is 300 feet in length by 64 feet wide. The northern end of the shop is used for sheet iron work, the central portion for coppersmiths' work and the southern end for plumbing work, while light sheet iron work, such as the construction of ventilators, ventilating trunks, casings, lockers and galley funnels, is also carried out on an upper floor at the southern end. The tool equipment includes a variety of pipe cutting, screwing and bending machines, shears and bending machines for sheet iron work, as well as punching and shearing machines, grinders, drills, etc.

A considerable amount of welding is done in connection with pipe work, both by the quasi-arc and oxy-acetylene processes.

Electrical Installation

The whole of the electric energy required in the yard is taken from the system of the Newcastle Electric Supply Company, so that no generating machinery is employed.

The electrical installation is, however, very extensive, as the total brake horsepower of the motors in the yard amounts to about 10,000 and electric energy is also used for lighting, welding, cooking and other purposes. Three-phase current is supplied at 6,000 volts and 40 cycles to three sub-stations in the yard, in which it is stepped down by static transformers to 440 volts for distribution to the shops. The sub-stations are conveniently situated, one near the western end of the

general stores building supplying the shops in the northern part of the yard, another near the head of the fourth building berth supplying the platers' shed and other plants in the neighborhood of the berths and the third in the power station building near the center of the fitting-out dock supplying the machinery in the power station.

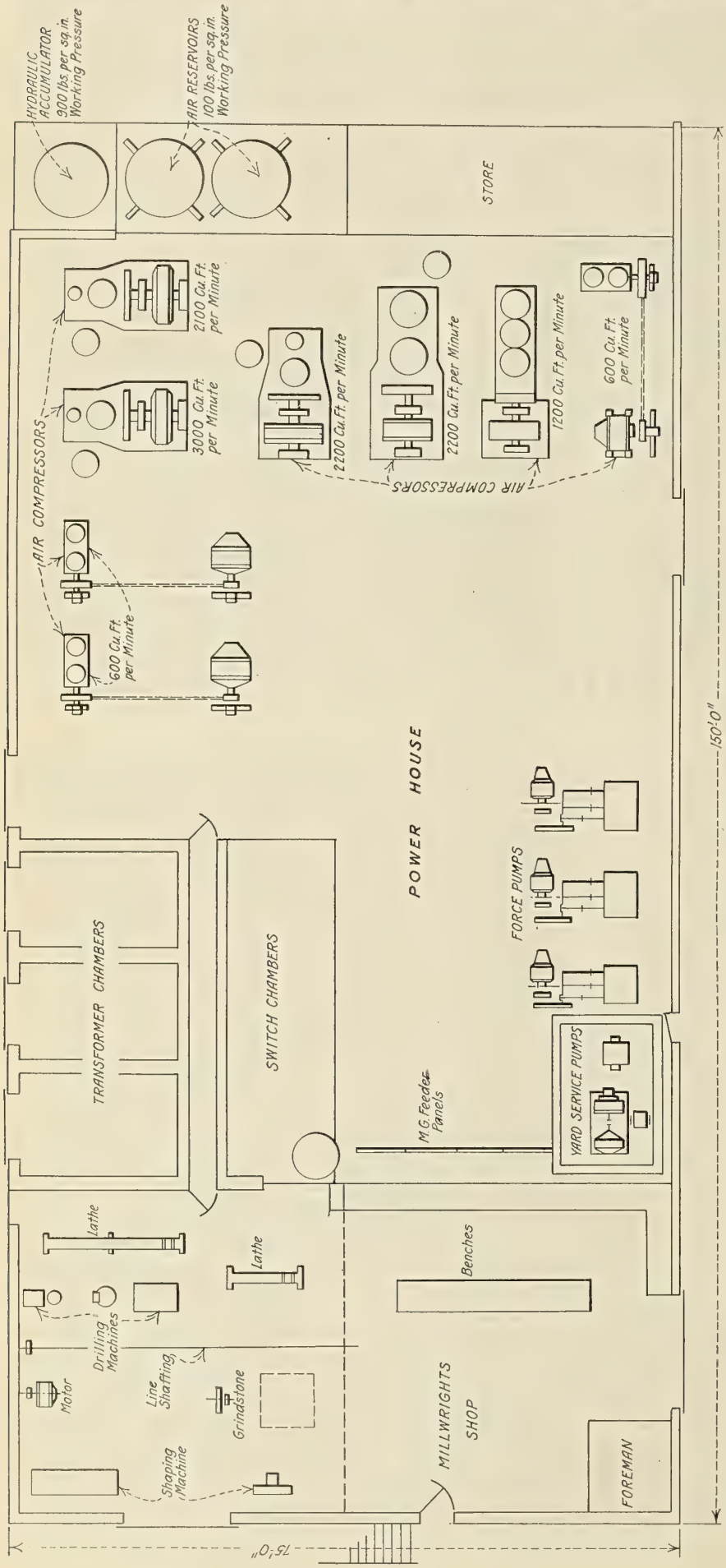


Fig. 27.—Plan of Power House

Power House

The power station building, which is used mainly for the supply of compressed air and hydraulic power, measures 150 feet long and 75 feet wide and is placed parallel with the fitting-out dock and near the center of the latter. A portion of the building, 38 feet in length, at the southern end is used as a millwrights' shop, in which general repairs to the yard plant are effected. The shop contains a few lathes, shapers, drills and other tools suitable for this class of work.

Air Compressing Equipment

The air compressing plant comprises eight electrically driven units. These supply air at a pressure of 100 pounds per square inch for operating power hammers, portable pneumatic tools and other appliances used in the yard. The largest compressor is capable of compressing 3,000 cubic feet of free air per minute and is directly coupled to an induction motor of 650 horsepower. A second machine, driven by a 400-horsepower motor, has a capacity of 2,200 cubic feet per minute and there is another compressor of the same capacity driven by an induction motor. Of the other compressors installed, two have capacities of 2,200 cubic feet and 1,200 cubic feet per minute, respectively, while the three remaining units are each capable of compressing 600 cubic feet per minute. The three small compressors are belt driven from Armstrong motors, while the other two machines are both directly coupled, the larger to a 400-horsepower motor and the smaller to a 260-horsepower motor.

Air is delivered into a vertical cylindrical receiver 30 feet long and 8 feet in diameter, placed in a separate compartment of the power station building at the northern end. From this it is distributed by 14-inch underground mains to all parts of the yard, the diameter of the mains diminishing to 9 inches at the most distant points. A 6-inch main, with branches at convenient intervals, is run down the sides of each of the large berths and arrangements are also made for the supply of air to vessels at the fitting-out dock. At various points in the yard where a particularly large demand for air occurs, such as the blacksmiths' shop and platers' shed, air receivers are provided of sufficient capacity to render the pressure fluctuations negligible.

Hydraulic Equipment

Hydraulic power is supplied by the three sets of pumps. These pumps, which are of Messrs. Armstrong's own

construction, are of the three-throw type and are each capable of delivering 90 gallons of water per minute against a working pressure of 900 pounds per square inch. They are driven through double reduction helical gearing by 75-horsepower motors, two of which were made by Messrs. Armstrong. The motors are automatically controlled by tappet switches actuated by the rise and fall of the accumulator, which is placed by the side of the air receiver in the compartment at the northern end of the building. The accumulator has a ram 18 inches in diameter with a stroke of 20 feet. Hydraulic power is distributed throughout the yard by 6-inch underground mains and the exhaust is returned by an 8-inch pipe to a tank in the power station.

The only other plant in the power station consists of two electrically driven centrifugal pumps which supply water for general use in the yard and also for testing tanks and watertight compartments of vessels under construction on the berths. These pumps, which are placed in the well shown in the foreground of Fig. 26, also circulate the cooling water for the compressors.

For use in connection with the overhauling and repairing of the plant in the power station, two 10-ton overhead traveling cranes operated by hand power are provided. One set of crane rails is extended into the millwright shop so that heavy machine parts can be transferred there for attention.

The Armstrong yard, being as it is the largest shipyard in England, occupies an important position among the prominent shipyards of the world, and the foregoing description gives an excellent idea of the completeness of the plant in every detail.

Cleaning Ships' Bottoms Without Docking

A SHIP cleaning plant has been developed by the Rapid Submersible Ship Cleaner Company, London, England, for scrubbing the underwater portions of the hull of a vessel while she is in port taking on or discharging a cargo. The complete plant comprises a steel boat 45 feet long, 11 feet wide and 5 feet 6 inches deep, which, when fully equipped, draws about 3 feet 6 inches of water. The boat is divided into three main compartments by steel watertight bulkheads. The forward compartment is arranged as a cabin for the crew of four men. The amidship portion is occupied by a winch and controlling gear for operating a submersible electrical scrubbing machine. The after part forms the engine room where a four cylinder kerosene engine of 45 brake horsepower is installed. This engine is direct coupled to an electric generator developing an output of 22 kilowatts at 100 volts. The engine also provides the power for propelling the boat through silent chain gearing to the propeller shaft. The vessel is equipped with electric light throughout, including powerful clusters for working at night.

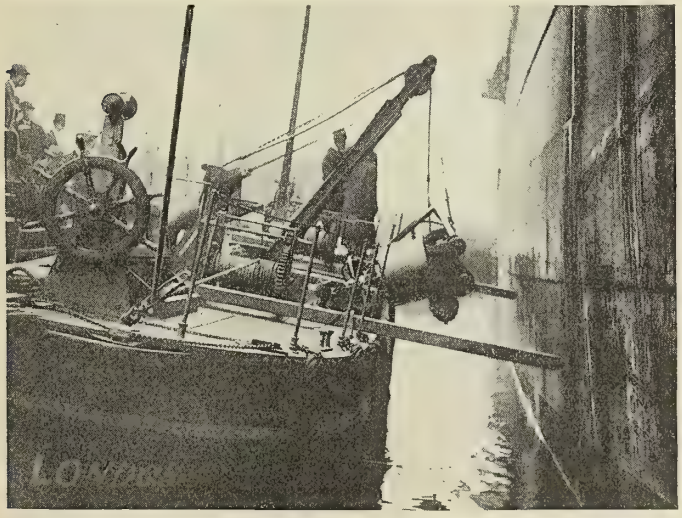


Fig. 1.—Submersible Ship Cleaner in Position for Lowering Against Side of Vessel to Be Scrubbed

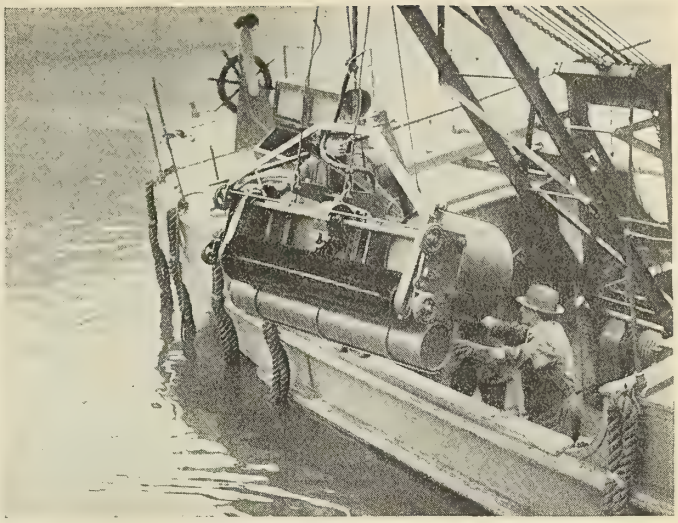


Fig. 2.—Arrangement of Scrubbing Brushes and Submersible Motor

The most interesting part of the plant is the electrical scrubbing apparatus, which consists of a steel frame to which a submersible electric motor of 12 brake horsepower is bolted. This frame also carries the scrubbing brush, which is circular in section and 5 feet long. The brush is made of coir fiber and brushes of varying degrees of stiffness can be used, according to the condition of the vessel operated on. The brush is revolved by the motor through suitable gearing. This motor also drives a bronze propeller which is situated at the rear of the brush; thus when the complete machine is lowered into the water at the side of a ship and the power switched on the circular brush revolves and is pressed firmly to the vessel by the thrust of the propeller. The whole machine is then lowered to the required depth and raised, brushing a strip 5 feet wide on the ship as it descends and rises. When the brush emerges the boat carrying the cleaning gear is moved about 4 feet and the operation repeated, until the whole length of the vessel has been scrubbed.

The scrubbing machine is raised and lowered by a specially designed electric winch with barrels for steel suspension wires and electric cable. The whole is controlled by one operator stationed near the boat's side. The scrubber is capable of removing any description of marine growth from the immersed part of a vessel and will do this without removing or injuring the paint on the vessel. If necessary, a special scrubber can be used and the whole of the vessel can be scaled of marine growths, paint, rust, etc., and left perfectly smooth and clean ready for repainting; thus the lengthy and costly operation of hand scaling is obviated.

Administrative Ruling.—Where the business on a particular trade route is adequately served by persons, citizens of the United States, with privately owned ships under American registry, or by Government owned ships in the hands of private operators under reasonable rates and conditions and free from unjust or undue discriminations or preferences, it is the policy of the United States Shipping Board not to establish or encourage the establishment of competing service on such route.

An Idle Merchant Marine.—The present situation in foreign exchange is not merely a matter of concern to international traders in securities. That merchant marine for which we waited for so many years is either tied up in port or is sailing for Europe in ballast. We have the tonnage. The time has come for supplying European buyers with the credit necessary to use that tonnage. Otherwise our plan for becoming a great maritime nation will prove just an empty dream.

Standardized Diesel Engines*

Harmonious Combination of Essential Diesel Engine Requirements with American Practicability

BY H. R. SETZ

SINCE Diesel engines have come into more general use in the United States, marked diversities in technique of design and manufacture have become apparent. On one hand we see established European types of engines copied in every minute detail and dimension with an uncritical exactness which indicates a complete lack of perception for their peculiarities and limitations; on the other hand, there is a tendency indiscriminately to discard the refinements and seemingly expensive constructive details characteristic of all successful Diesel engines in favor of the cheap and inadequate practices that dominate ordinary gas engine, and even steam engine construction. The former leads to excessive cost due to unsuitability of many details to American shop methods and operating conditions; the latter results in rapid deterioration and complete failure under anything like the operating requirements which modern Diesel engines can meet.

In what follows a line of engines is described that represents a comprehensive effort at a harmonious combination of essential Diesel engine requirements with American practicability. As the outstanding feature of the latter the author perceives the endeavor of standardization in the sense of adopting recognized constructive elements to the greatest possible variety of applications compatible with accepted engineering principles. The Diesel engine is essentially simple, whether built in the four cycle or two cycle type, and the following expositions show that this simplicity can be given extremely practical expression through the channels of standardized design, if conceived broadly enough from the outset. It will also be seen that neither in the four cycle nor in the two cycle form does this standardization demand departure from accepted Diesel engine technique, but rather to the contrary that such procedure is conducive to the attainment of results which without it seemed far beyond practical realization.

The aggregate capacity of four cycle Diesel engines in operation today in all parts of the world amounts to well over three million horsepower. This formidable output is obtained from engines ranging from only a few horsepower per cylinder up to units where 400 horsepower are being developed in one single cylinder. Their field of application covers any requirement where power is needed at a steady enough rate to justify their comparatively high first cost. With very few exceptions, Diesel engines are not found in places where power requirements are of a seasonal or such fluctuating nature as to result in a low average load factor and there are very compelling economic reasons why their application gravitates preponderantly towards fields of heavy and essentially continuous power demand such as central station work and marine installations.

As a result of such severe and diversified application extending over a period of approximately twenty years of steady and progressive development, the principles peculiar to successful four cycle engine construction have become well established. In the application of these principles from the viewpoint of standardization, it is not necessary to cast about for fundamentally new forms, as existing types of engines present a wide and rich choice of constructive features which have the makings of a standardized product.

General Engine Structure

Beginning with the frame structure, there has come into increasing use for all advanced service requirements, such as marine installations, a construction consisting of the bed plate, vertical frame members and a beam-like top member mounted over the latter which serves as a support for the cylinders. The widest and most consistent application of these features is embodied in the modern Burmeister and Wain engines, where the top member or cylinder beam takes the form of a deep box section which surrounds the cylinders over their entire length. The extreme rigidity obtained with this construction has to no small part contributed to the success of these engines.

In a broader conception this same general frame structure forms the basis for the engines dealt with in this article, the principal modification consisting in the method of mounting the cylinders. In the Burmeister and Wain engines bored seats are provided directly in the cylinder beam for the top and bottom ends of the cylinders, thereby providing one fixed position for each cylinder relatively to the common beam. Since such a beam contains from two to four cylinders it becomes a rather bulky and heavy casting in which requisite accuracy for the cylinder seats, particularly as regards parallelism of the cylinder centerlines, cannot be readily obtained. Proper alinement of the cylinders with their respective cranks depends entirely upon this point. Corrective measures for errors in machining are difficult to apply. The delicacy of this boring operation in so large a piece can therefore be readily appreciated and a modification which eliminates this operation is thoroughly desirable from a manufacturing point of view.

The seating of the cylinders at their extreme ends directly in the beam requires so close a spaced relation between these parts that the accommodation in the same beam of a variety of cylinder sizes or types is practically excluded. So far as considerations of strength and rigidity are concerned—the main reasons for the use of a cylinder beam—a very much freer relation between these parts is permissible. The elimination of bored cylinder seats therefore suggests itself as a means for securing wider adaptability for so large and expensive a piece as this beam.

A-Frames and Tie Rods

Fig. 1 shows a frame structure in which the foregoing considerations have been given due regard. The vertical frame members take the form of A-frames which are mounted on the bedplate in the plane of the main bearings. The deep, box-shaped, cylinder beam rests on top of the A-frames and is secured to the latter by means of tie rods of such length as to insure the transmission of forces well into the structure of the parts which they connect. For this purpose each tie rod is carried from the top of the cylinder beam to a point in the A-frame where the distribution of material insures most favorable stress distribution, and from this point on down the cross-sectional development of the A-frames easily permits direct force transmission into the bedplate.

A rigid method of fastening is thus obtained which does away with the inconvenience of a great number of flange bolts at so inaccessible a place as is found where the top of the A-frames joins the underside of the cylinder beam, and, due to their comparative shortness, elastic deformations in the tie rods can be kept within practical limits without having to resort to excessively heavy sections. The deformation of the lower part of the A-frames, such as is easily possible by careless tightening of tie rods which run clear through to the

* Copyright, 1921, by H. R. Setz.

underside of the bedplate, is also made impossible. These short tie rods, furthermore, permit of easier handling in erection and overhauling of the engine, particularly in tight places such as on board ship. Being shorter than the height of the A-frames, they can be lowered and temporarily secured so as to be contained entirely within the A-frames and removed with these sideways from underneath the cylinder beam. The crank shaft is bedded deep enough in the bedplate to clear the underside of the A-frames, thus readily permitting of their sidewise removal without disturbing any other engine parts. This is a feature which contrasts very favorably with some of the expedients recently adopted for accomplishing similar results.

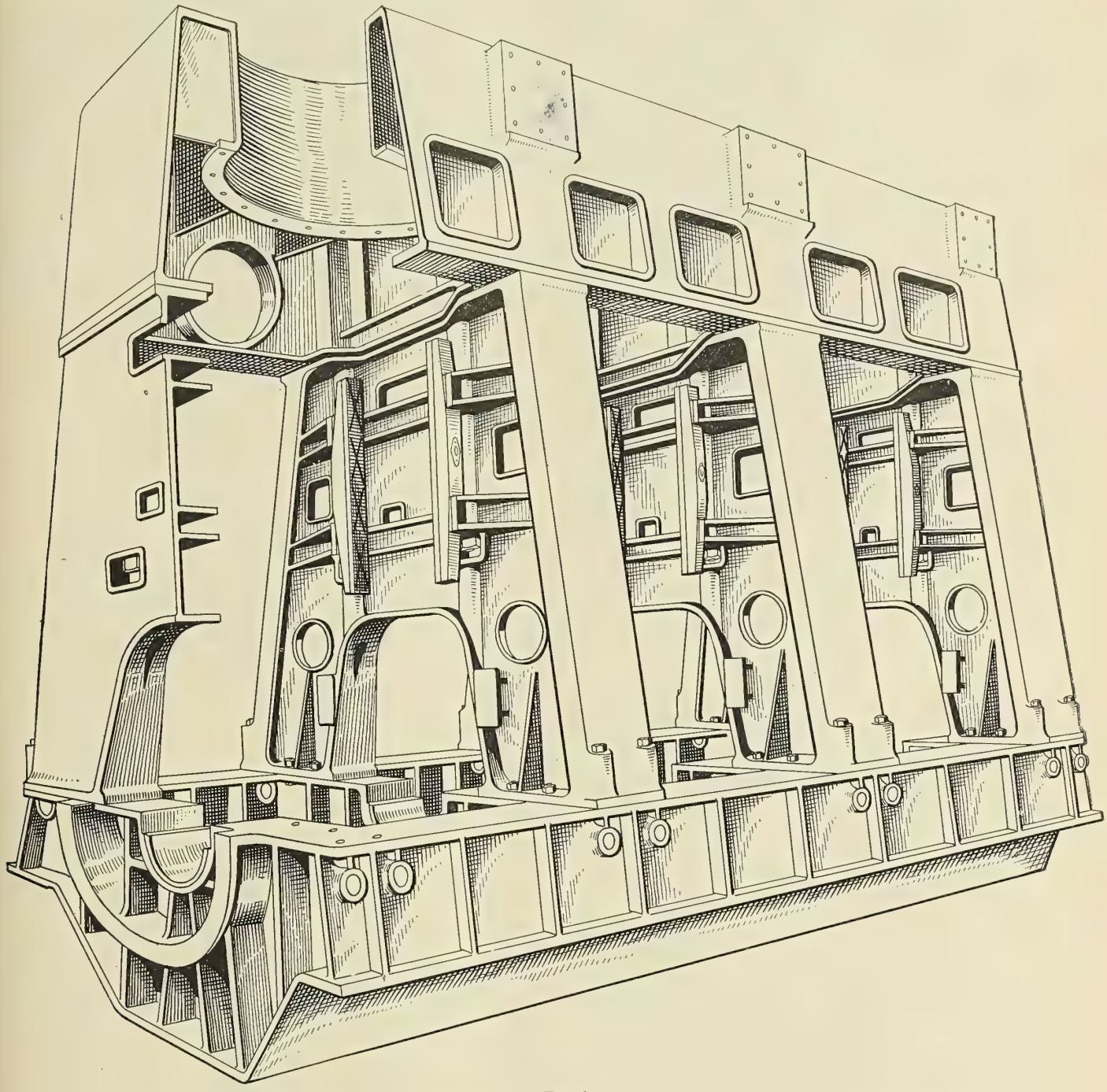


Fig. 1

Cylinder Beam

The cylinder beam, running the whole length of the engine, effectively braces the upper ends of the A-frames and forms the bridge between the centerline of the forces due to the working pressures in the cylinders and the re-acting forces of the main bearings. The working forces of the engine are therefore transmitted to the bedplate in the planes of the main bearings and longitudinal bending of the bedplate is thereby eliminated. What bending there is occurs in the transverse girders of the bedplate and is only of slight amount, namely, that determined by the amount of span in the arch of the A-frame required to straddle the main bearing caps. The elimination of all considerable bending deflections from that part of the engine structure which contains the delicate and important working surfaces of the main bearings and the accommodation of these strains in so favorably proportioned a piece as the cylinder beam is a matter whose importance cannot be overestimated, especially for marine engines.

In the cylinder beam shown in Fig. 1 no provision is made for bored cylinder seats and all machining processes on same are reduced to ordinary facing and drilling operations without calling for any particular degree of accuracy. Its function as a load transmitting member is reflected in its deep box

section, augmented by the tubular extensions of the cylinder openings which project well into the interior of the beam. Exceptional rigidity is thus obtained at a minimum expenditure of metal.

Cylinder Seats

The cylinder seats are located in separate flanged rings (see Figs. 2 and 3) which can be conveniently bored to any desired degree of accuracy on a lathe or vertical boring mill. The upper ring, into which the cylinder proper is inserted in the usual manner so as to be rigidly held with the cylinder head in place, rests with its flange squarely on the top of the beam. The bottom ring is slidably fitted over the lower end of the cylinder and bolted against the flanged face at the lower end of the tubular opening which runs parallel to the top face of the beam. The cylinder passes through this tubular opening with considerable clearance, thus forming a large water jacket space which the upper and lower cylinder rings close off; this also permits of independent lateral movement of each cylinder relatively to the cylinder beam, thereby making possible the convenient and exact alinement of each cylinder with its respective crank. After having been properly located the flanges of the cylinder rings are dowel pinned, which definitely centers the cylinders.

Bedplate

The bedplate is a rigid casting consisting of longitudinal and cross girders of deep I-section with wide flanges on top and bottom, which are effectively reinforced by suitable ribs. The cross girders carry the main bearings in bored seats. The whole engine bedplate is made up of symmetrical sections, each comprising two or three cylinders, for the main part and the narrower compressor section at the forward end (see Fig. 3). The bottom of the crank pit under the main sections is formed by one continuous welded steel pan of any desired depth to meet particular conditions, and, owing to the fact that the bolts which hold this pan in place are accessible from the interior of the bedplate, it becomes possible to maintain an oiltight joint after the engine is erected.

Main Bearings

The main bearings take the form of babbitted cast iron shells, readily rolled out of their bored seats without requiring removal or even lifting of the shaft. Except in stationary engines, where one of the center shells is made slightly longer so as definitely to locate the shaft axially, all shells are of the same length and interchangeable. With the exception stated, all these shells have liberal end clearances to permit axial expansion of the shaft relatively to the cooler bedplate. The A-frames rest with broad flanges on the bedplate and ample space is provided for accessibly locating through bolts of liberal proportions. Their design is such that for a given cylinder group the extreme end frames are alike and interchangeable, as are the frames between cylinders. In this manner only two patterns are required and only two kinds of castings need be carried in order to cover any number of cylinders that may be required for a complete engine. A conspicuous feature of this frame arrangement is the wide openings through which ready access can be had to the interior of the engine. Flanged edges along the outside contour of the A-frames facilitate the convenient placing of oiltight doors.

Crossheads

For heavy duty service, and for marine installations in particular, the use of crossheads is coming into more and more general use. Experience has taught that their slight extra cost is offset in a short time by reduced wear and the greater ease of maintaining exact clearances on those parts which are subject to sliding wear. This is so well understood today that it requires no further comment, although it may be mentioned in passing that leading European builders are today applying

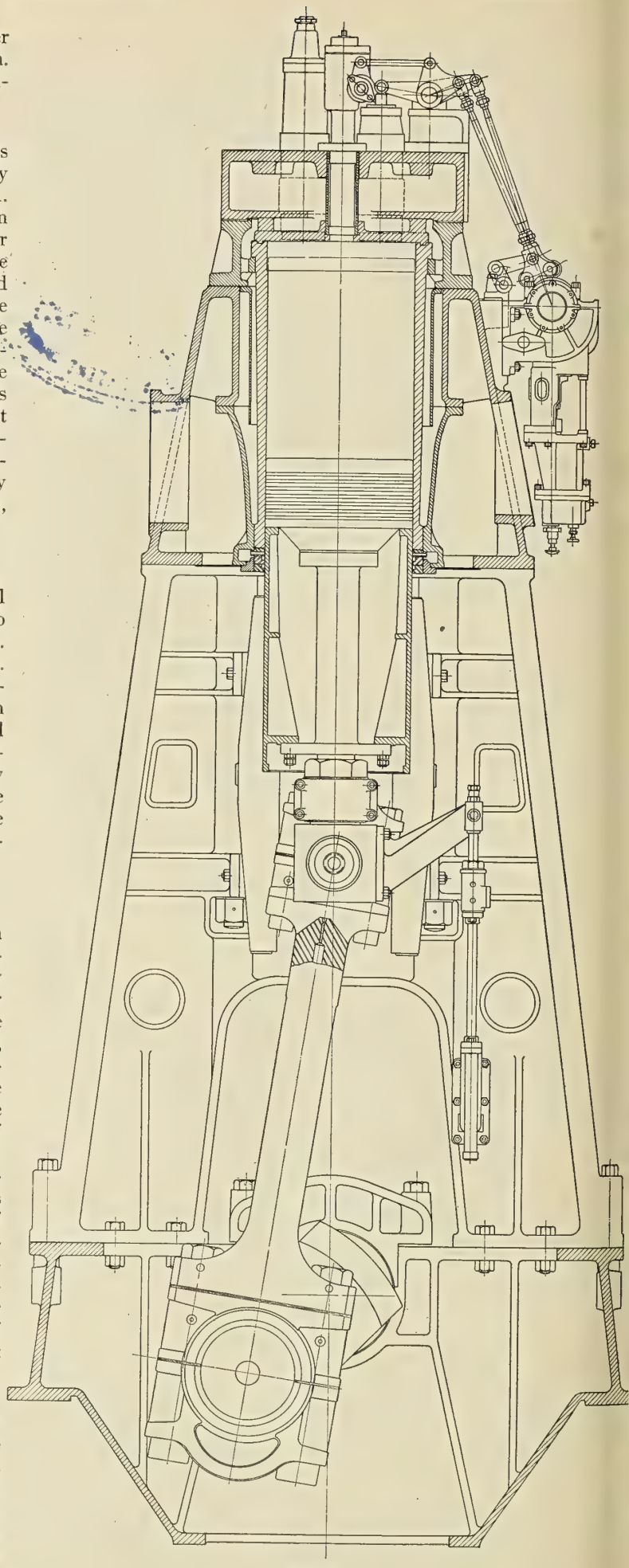
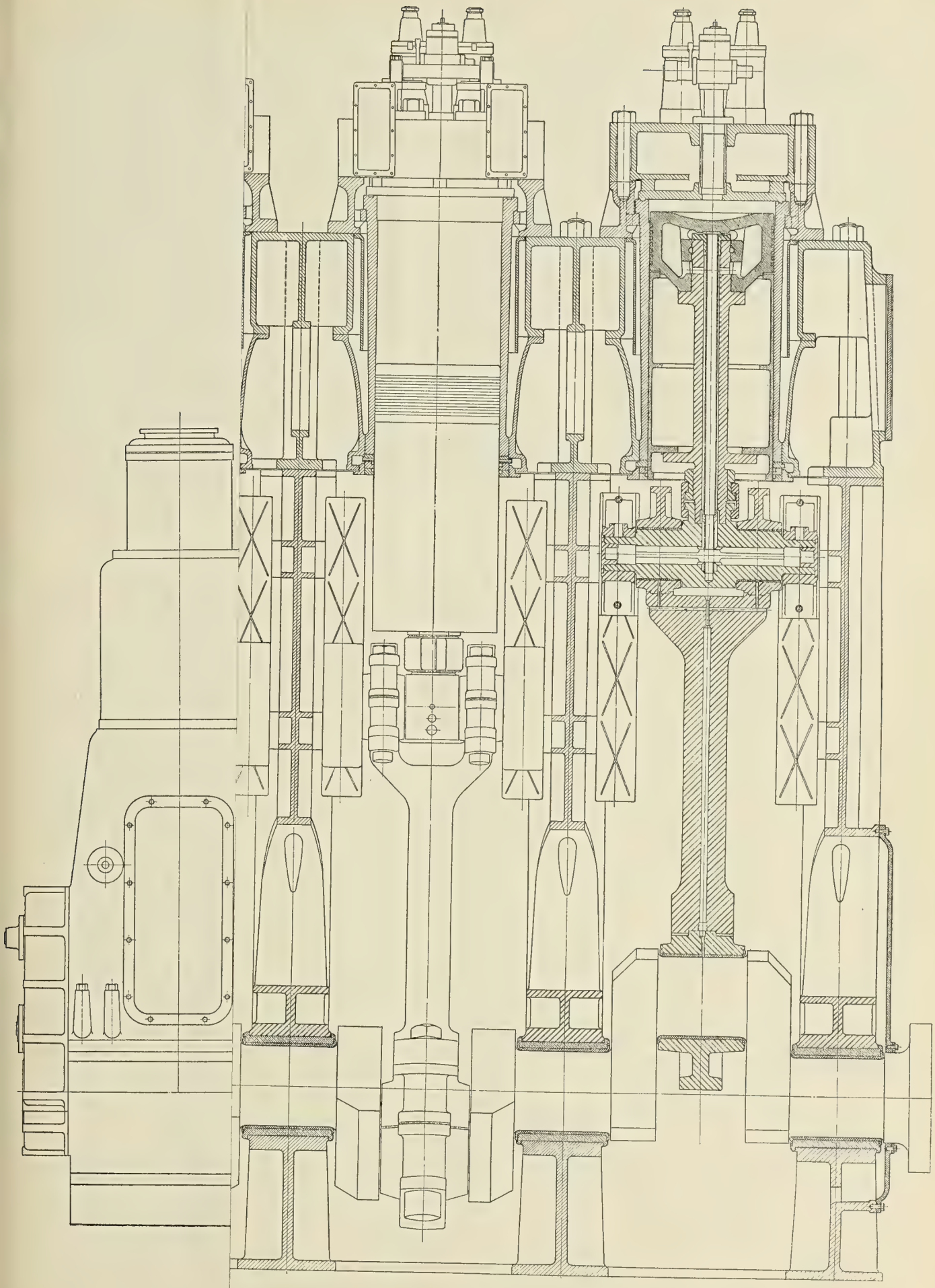


Fig. 2



STANDARDIZED DIESEL ENGINES

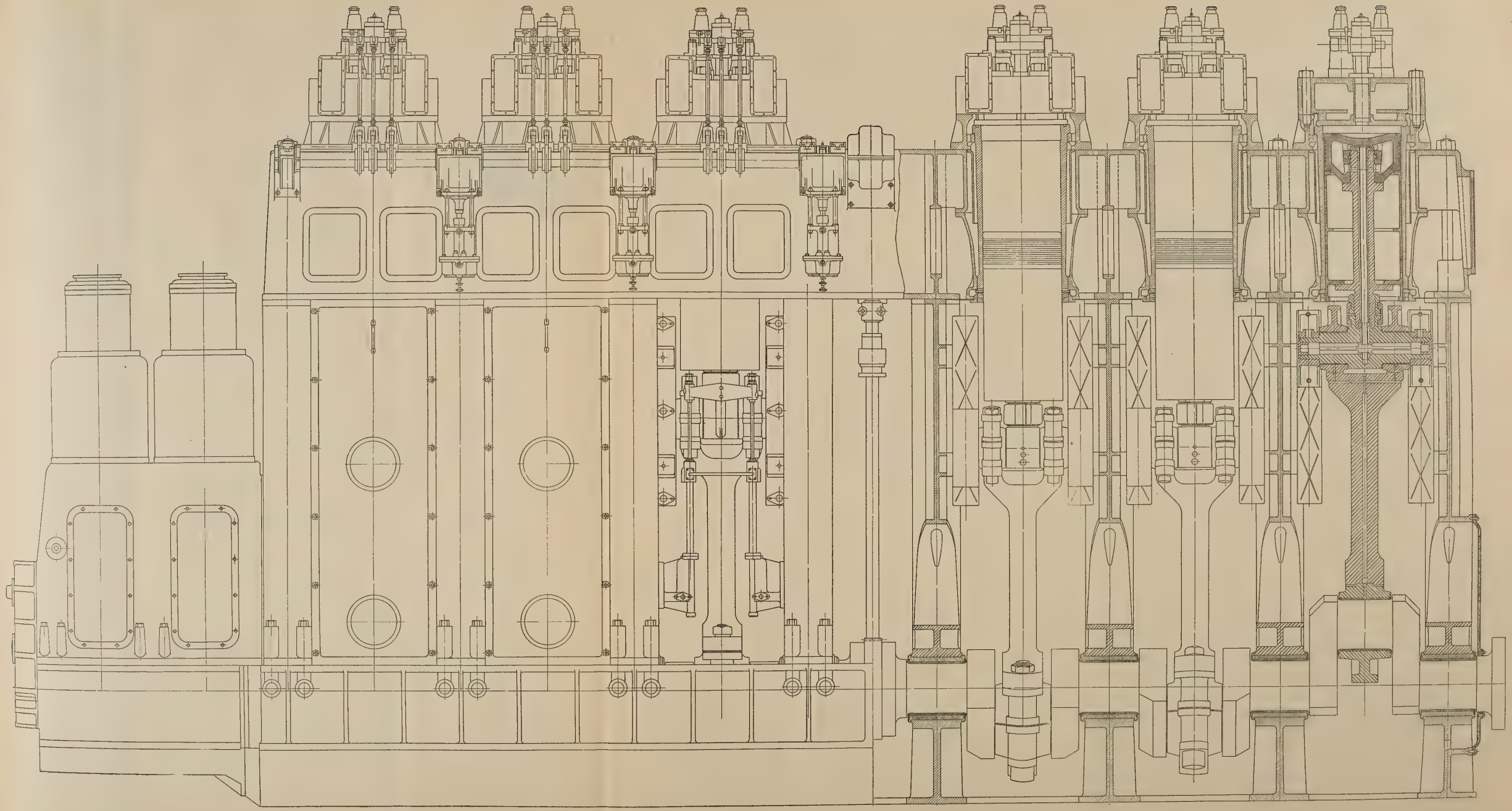


Fig. 3

MAR 14 1921
U. S. PATENT OFFICE

crossheads to four cycle marine engines of as low as 17 inches cylinder bore, a practice which only a few years ago was considered superfluous and commercially impossible. There are very good reasons why American marine engineers ought to heed this tendency.

As to the type of crosshead to be used on Diesel engines, there still exists today a very considerable diversity of opinion. With very few exceptions the types and general arrangement of crosshead constructions bear the earmarks of their origin, the steam engine. Center crossheads, running in bored guides, was the first form used in Diesel engines. Their inconvenience in manufacture, however, especially in larger units, and more so their limited accessibility and inadequate means for adjustment for wear, have failed to make them very popular. From this form it was only a short step to the center crosshead with flat guides such as are extensively used on marine steam engines. Here provisions can readily be made for adjustments, and considerable accessibility, also, can be obtained if the frame columns which carry the crosshead guides are placed in the plane in which the connecting rod swings. This latter requirement, however, successful as it has proved to be with steam engines, is a serious detriment when applied to Diesel engines. Since the full working forces are transmitted through these columns into the bedplate, the latter is subjected to heavy longitudinal bending moments, and, on account of the necessarily wide span required for clearing the path of the crank pin boxes, also to very considerable transverse bending stresses.

Side Type Crosshead

Another type of crosshead adopted for Diesel engines is the side crosshead, most extensively used on marine steam engines. Its comparative freedom from temperature influences and, not the least, its cheapness are the features which have given it this wide popularity. The front column only is made use of to carry the crosshead guide; inasmuch, however, as this column is still placed in the plane of connecting rod, its use is just as unfavorable for load transmission to the bedplate of a Diesel engine as the previous one. It was, however, through adaptation of the side crosshead to practical Diesel engine requirements that the first really successful crosshead type marine Diesel engine came into existence. We are referring to the Burmeister and Wain construction where independent A-frames are mounted over the bedplate in the plane of the main bearings with the crosshead guide extending from one to the next of these A-frames.

This is no longer as simple an arrangement as the side crosshead used on the steam engine. The fact that the one guide for each crosshead is supported on two entirely separate frame members introduces a rather delicate erection job on large pieces and in positions which require no small amount of painstaking care. Probably the least desirable feature, however, is the fact that the crosshead side of an engine so constructed is practically entirely closed off as far as convenient access into the interior is concerned, a matter of no small consequence from the operating point of view. This arrangement is, of course, also objectionable from the viewpoint of standardization, since the resulting departure from symmetry about the center plane of the engine requires right and left hand or inboard and outboard parts.

Double Center Crosshead

Considerations of this nature have brought increasing favor to the so-called double center crosshead. Having originated in large steam engine practice, it is coming into more general use on Diesel engines and has been adopted for the line of engines here described. The two crossheads at the end of the crosshead pin (see Figs. 2 and 3) are entirely symmetrical and interchangeable. Each carries a pair of babbitted, interchangeable slippers which can easily be removed without disturbing any other parts when wear makes readjustments necessary. The side thrust from these crossheads is taken up by water-cooled guides of plain box-shaped cross-section, and requirements of strength and rigidity, as well as ease of alinement, are met by the provision of two supports for each guide at the points of maximum side thrust.

These supports take the form of deeply ribbed brackets cast integral with the A-frames (see Fig. 1). Splitting the side into two halves has the double advantage of making possible the use of a larger aggregate surface and of greatly improving accessibility from both sides of the engine. The four guide rails (Fig. 18) can readily be so placed as to allow the downward withdrawal of the piston. When it is remembered that the pulling of the piston upward sacrifices headroom, makes necessary the complete dismantling of pipes, tubing and valve gear, not to mention the wasted time and labor incident to the disturbance of adjustments and roller clearances, the advantage of the arrangement can be appreciated.

The removal of the pistons from below is further facilitated by the absence of any partition separating the underside of the cylinders from the crank case. In order to prevent the dripping of carbonized oil residues which will work past the pistons and would drop into the crank pit below, a light tubular piston extension is used from which excess oil and residues are scraped off by two inwardly closing snap rings in the lower end of the cylinders. A small annular chamber surrounding these scraper rings serves as a receptacle for the oil thus collected.

This arrangement, it will be observed, is identical with the most accepted practice on modern two cycle engines. Considering the total forces that have to be dealt with here the slight extra weight added to the reciprocating masses by the piston extension is of hardly noticeable consequence; on the other hand, the absence of a partition underneath the cylinders results in reduced engine height, an incidental feature which for certain installations is of considerable importance.

The Piston Rod

The piston rod is hollow and serves with its integral top flange not only as a support of the piston but also conveys cooling water to and from the latter. By means of a telescope tube all the water is first conducted to the crosshead where a baffle plate forces it to flow through the whole length of the hollow crosshead pin before reaching the central bore which communicates directly with the hollow piston rod. Similarly, the discharge is conducted through a central tube in the piston rod directly to the crosshead pin and thence out through a second telescope tube.

In order to make possible such a well directed flow of cooling water, and for other reasons which will become more apparent later on, the piston rod is secured to the crosshead pin by means of a split collar backed by a heavy nut on the threaded end of the piston rod. The absence of any fastening means whatsoever on the underside of the crosshead pin permits the upper end of the connecting rod between the two crosshead pin boxes to be made exceptionally substantial and rigid.

In recognition of the importance of preventing cooling water leakage into the crank pit, particular care has been given to the packing of the telescope tubes. Aside from self-adjusting metallic packing rings, an air seal is used which is kept under a pressure of from twelve to fifteen pounds per square inch from the first stage of the air compressor. With a negligible consumption of air, leakage water past the packing rings is prevented from passing the air seal. This arrangement combined with non-corrosive telescope tubes makes possible the use of sea water for piston cooling, thus greatly simplifying the whole cooling water circulating system as compared with such arrangements which require fresh water piston cooling.

Where there are more than three cylinders in one engine the crank shaft is made in symmetrical sections of two or three

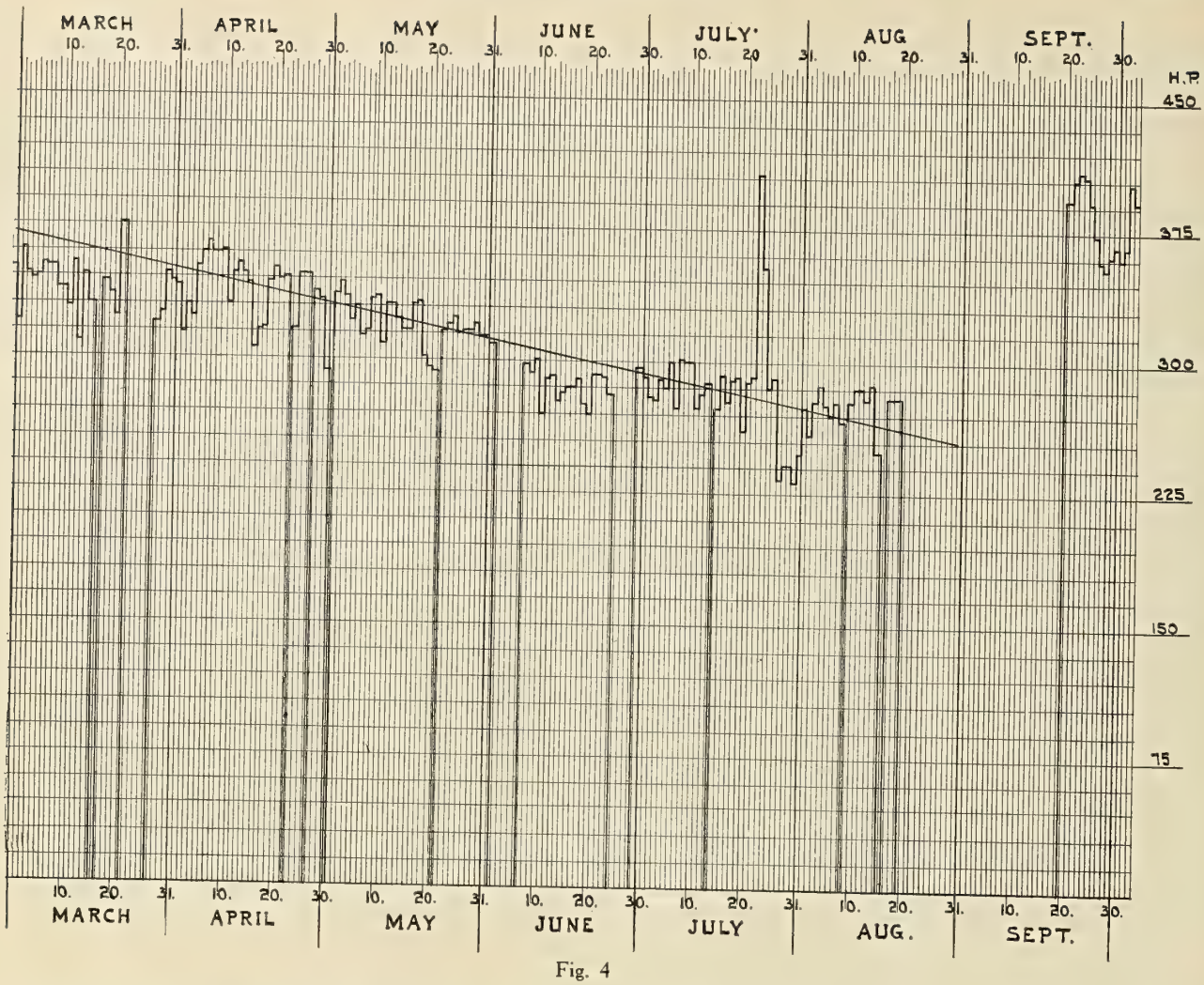


Fig. 4

cranks per section, reversible end for end; the flanged joint is placed between the two middle cylinders in the same plane with the joint in the bedplate. Each main bearing is supplied with lubricating oil under pressure through an indicator, where not only the actual flow can be observed but also measured and regulated; an automatic alarm gives warning when the supply to any bearing reaches a minimum. Crank pin and crosshead pin boxes as well as crosshead shoes are supplied with pressure oil in the usual manner through drilled holes in the shaft and connecting rods.

Water Cooling

In considering any type of engine structure, too much emphasis cannot be laid upon the facilities which are afforded for insuring adequate water cooling of the cylinder and cylinder heads. Adequate water cooling implies not merely the presence of a body of water in contact with the heated surfaces, but also that it will be in active and well defined circulation over these surfaces. The rate of heat transmission between the surfaces and water which is agitated and in motion is appreciably higher than if the water is flowing very gently; sluggish flow causes precipitation of mineral deposits, thereby further imparing the transmission of heat. Low mean temperatures of the casting walls are highly desirable for reducing heat distress, for improving lubrication and for maintaining the volumetric efficiency of the engine. To what extent this may affect actual operating results can be seen with unusual clearness from the record of a three cylinder, four cycle, 450 brake horsepower Diesel engine of conventional heavy duty design.

Fig. 4 shows graphically the average daily output of this engine, covering the period from the month of March until the following October; the engine was put in operation the previous June. This particular engine was one of several other units in a station where the load conditions are practically steady and continuous and where, on account of the superior economy of the Diesel engine compared with the other units (steam), the former was uninterruptedly kept loaded to its highest possible capacity. About six months after this engine was put in service it became apparent that its capacity was falling off, which manifested itself by increasingly smoky exhaust at loads below the maximum rated load and, if forced, in overheated and seized pistons (trunk pistons, uncooled). Gradually this condition became worse, and in March, where our diagram begins, 350 brake horsepower was about as high a load as it was deemed safe to carry. On March 21 and 22 an attempt was made to put more load on this engine, with the result that the piston seized and required regrinding, hence the shutdown of several days.

The continued dropping off in load capacity at an average rate of approximately 15 horsepower per month was rather puzzling at first, especially in view of the fact that all the valves were kept in satisfactory condition, which is borne out in the chart by the steady runs that were being made, as high as 646 consecutive hours by the actual station log. From all the surrounding circumstances it gradually became apparent that the trouble was due to heat distress. This was verified on July 22 and 23 when arrangements could be made to circulate an extra large quantity of cooling water through this engine. A load about 50 percent higher than the then prevailing average could be carried for 37 consecutive hours.

When it finally became possible to shut this engine down for a thorough inspection and overhaul, a mineral deposit was found on the cylinders and cylinder heads which in places

was fully ¼ inch thick. The diagram shows to what extent operating conditions were improved by the removal of these deposits; a load up to within 90 percent of the full rated load could be carried without any signs of distress, and that in spite of the fact that neither cylinder liners nor pistons were anywhere near in normal condition after the previous hard usage.

Water Jacket Areas Should Be Restricted

Experiences like these, and the considerations already referred to, account for the increasing tendency to depart from the "liberal" water spaces still occasionally emphasized in the trade literature. Water jackets should be designed from the very opposite point of view, namely, that of restricting areas.

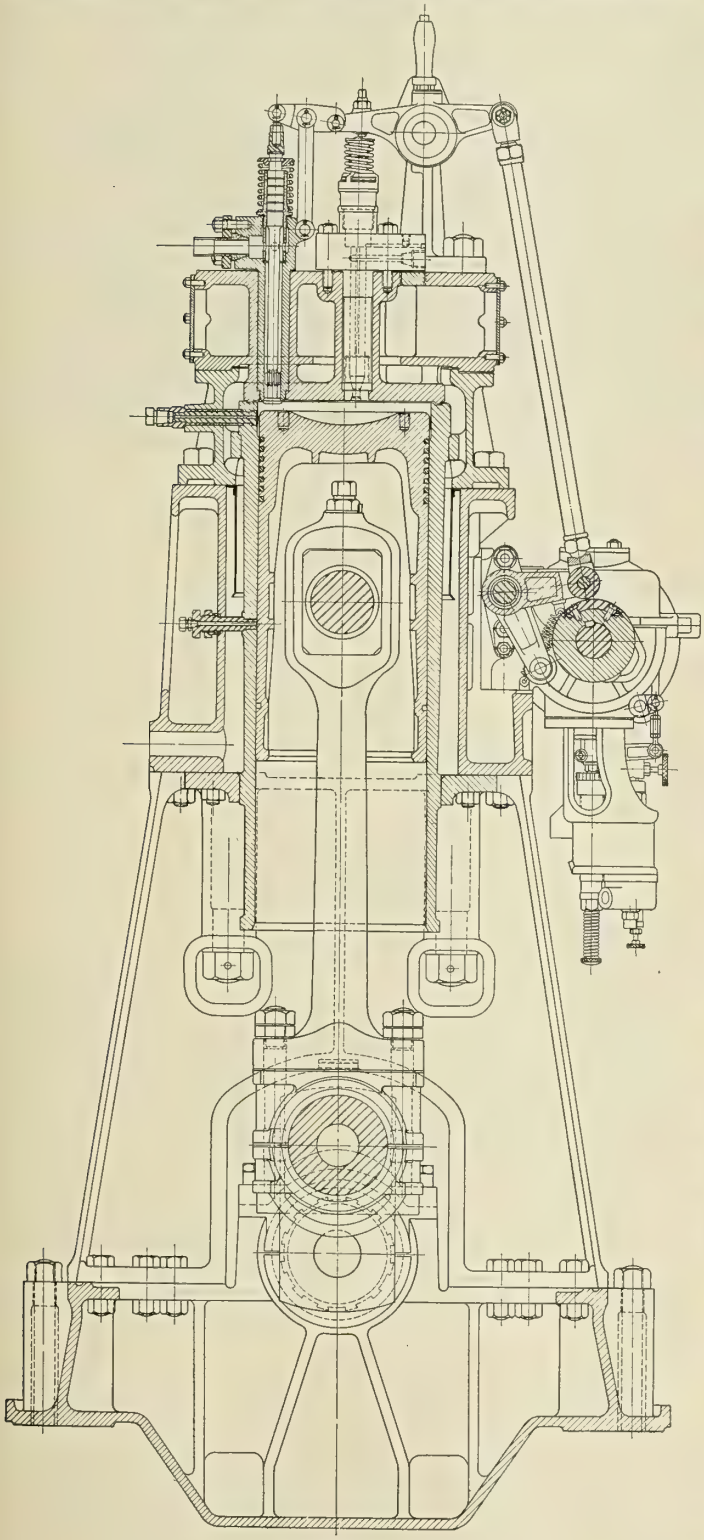


Fig. 5

This should be done especially in the neighborhood of more highly heated cylinder parts, over which the water must be forced to flow at a velocity high enough to insure rapid heat transmission and by mechanical agitation to forestall the deposit of minerals. The cylinder beam construction as illustrated in Fig. 1 lends itself particularly well to the conscientious observance of these principles. As may be seen from Figs. 2 and 3, it is a simple matter to secure under the flange of the upper cylinder ring a barrel-like baffle which forces all the cooling water actively to circulate around the cylinder in a thin sheet.

The same idea is carried through in the design of the cylinder head. Since this is provided with a baffle plate in the water space immediately above the combustion chamber wall, all the cooling water is caused to pass over this heated wall at a fairly high velocity, which increases towards the center where the most intense heat conditions occur around the fuel injection valve. This feature is obtained without undue complications to the cylinder head casting. A part of its jacket wall is formed by the upper cylinder ring, a construction

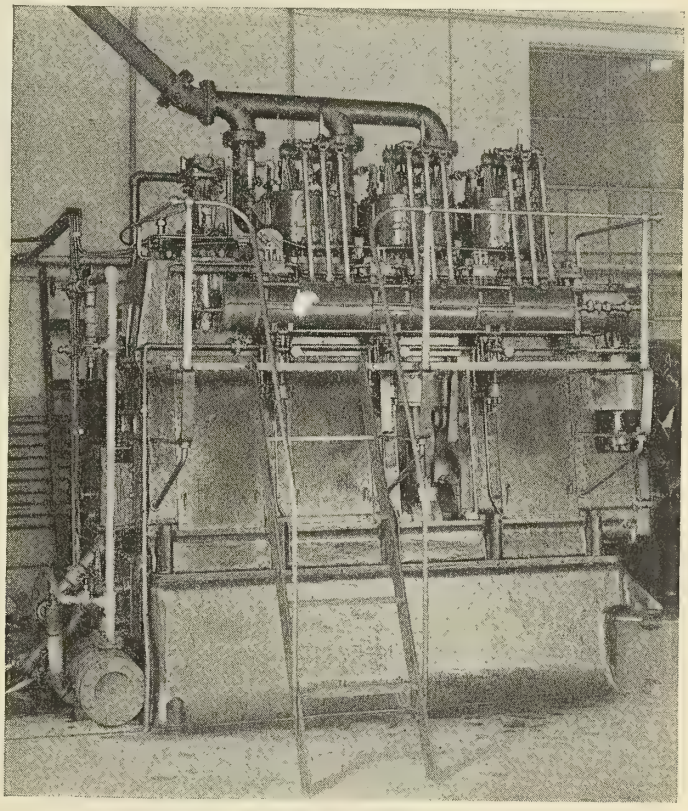


Fig. 6

which makes the narrow water passage space accessible all around from underneath for core work and cleaning. The intensification of cooling due to the flow of cooling water around the outer edge of the cylinder and cylinder head wall contrasts favorably with those constructions in which these walls take the form of heavy flanges that are touched by the cooling water only on the top and bottom respectively. The cylinder head studs can be so placed as to permit their convenient packing against coming into contact with the cooling water, a consideration of importance for salt water service.

Three Cylinder Trunk Piston Engine

Fig. 5 shows the transverse section, and Fig. 6 shows a photographic view of a three cylinder Diesel engine in which the foregoing ideas as to frame construction, cylinder mounting and cooling have been incorporated. The ease of manufacture, beginning with the simple castings, the convenience of machining and the ready accessibility in erection were mat-

ters of general comment. This being a trunk piston engine, with the connecting rod side thrust transmitted directly into the cylinders, it afforded a good opportunity to test the rigidity of its frame structure. As was to be expected from the favorable cylinder mounting, the elastic deformations so typical of high speed engines are minimized to an extent which makes the engine practically free from vibrations. Since this is the largest single factor that affects maintenance of the accurate alinements required by Diesel engines in order to reduce wear, the advantages of this arrangement can readily be appreciated.

The provisions for efficient cooling have likewise met all expectations. There is a just barely perceptible temperature increase on the external cylinder and cylinder head walls even under the heaviest loads; the pistons run exceptionally cool and the lubricating oil which works down between cylinders and pistons is entirely free from carbonized residues. The rapid circulation of cooling water over the cylinder head causes extremely efficient cooling around the various valve cage seats; as a result the cages themselves as well as the valves are kept at so even a temperature under all operating conditions that clearances of the valve gear parts can be set with a degree of closeness that insures quietness and ease of operation at highest speeds.

(*To be continued.*)

The United States Will Lead in Motorship Building, Predicts Dr. Lucke

AMERICA will lead the world in motorship development just as she does in the motor car industry, Charles E. Lucke, professor of mechanical engineering at Columbia University, predicts in a survey on the relative merits of motorships and steamships made for the American Society of Mechanical Engineers.

Professor Lucke, who during the war was director of the United States Navy Gas Engine School, a Columbia University war institution, which trained crews to man submarine chasers in European waters, asserts that this country is entering upon a programme of motorship construction and that although this industry developed in Europe the leadership in building and operation will eventually pass to America. He points out that the history of the motor car industry is likely to repeat itself in the motorship. At the outset Europe led in that industry, but as the art developed the primacy shifted to this side of the Atlantic.

Rising Costs Have Increased Motorship Building

Dr. Lucke says that rising costs due to the war have increased motorship building at the expense of steamship construction and that future conditions so far as they can be forecast favor the motorship over the steam vessel as a vehicle of ocean commerce.

"European shipbuilding nations," states Professor Lucke, "the Scandinavians at first, but now practically all, including England, France, Holland and Italy, in addition to Germany, have for some years been building large Diesel engines and auxiliary equipment for the driving of seagoing vessels. In more recent years this movement has been accelerated by the proved economy of the equipment that has been found most reliable and the reduction in cargo-carrying costs by the motorship over the steamship. The raising of all prices and costs by the war has directed attention to every possible source of saving, and this, among other things, has further increased the volume of motorship building at the expense of steamship construction.

"During this whole period of experimental development of the propelling machinery, and with its perfection the large-scale demonstration of lower cargo-carrying costs over competing steam equipment, America has done nothing with the motorship. On the contrary, there has been a great increase in steam cargo carriers, first as a result of war demands and later as a national movement for the re-establishment of the American merchant marine in a position of some commanding importance at sea.

European Countries the Pioneers

"While America has been building more and more steamships, the Europeans have been building fewer, in proportion, replacing them by motorships, partly on the basis of demonstrated reliability, but mainly on the basis of proved reduction of operating costs. Only now have our shipping interests passed the period of consideration and entered upon that of action.

"It has taken some years to convince American shipping interests that the motorship is reliable; it has taken some years to convince these same interests that America can build satisfactory engines and that they need not be reproductions of European models; but it can be said definitely that shipping interests have now reached the point of accepting this situation. It is admitted that American Diesel engines can be built equal in quality to those built in Europe and also at competing costs, but in spite of this there has not as yet been any great adoption of the motorship in this country. Only a few have been contracted for today, although a great many projects are under consideration.

The Problem of Using Lower Grade Oil

"To adapt the motorship to the burning of the lower grade oil, which seems to be really the only step necessary to eliminate even the residual doubts remaining in the minds of American shipping interests, there are only two factors of any importance to be studied, namely, spraying of the oil and ignition temperatures.

"It may be said, therefore, that America is about to enter on its programme of motorship development and use, and, in fact, has actually entered it within the last year. The rate of adoption depends upon the speed with which established facts become recognized and known, and are followed by building orders. It is of considerable interest to note that the motor car industry, in which America now leads the world, developed in Europe in quite the same way as the motorship industry, and it is not too much to expect that once American interests become convinced that the motorship is what the Europeans think it is, American motorship construction and operation will also lead the world."

Annual Meeting of the Institution of Naval Architects

THE annual meeting of the Institution of Naval Architects will be held on March 16, 17 and 18 in the lecture hall of the Royal United Service Institution, Whitehall, W. C. 2, London. An evening reception will be held in the Naval Museum of the Royal United Service Institution on the evening of March 15, and the annual dinner will be held on the evening of March 16 in the Grand Hall, Connaught Rooms, Great Queen Street, Kingsway, W. C.

A gold medal will be awarded by the Council to any person not a member or associate member of the Council, who shall read a paper at the forthcoming meeting which, in the judgment of the Council, is deemed to be of special merit. The Council will also offer a premium of books or instruments to the reader of any paper, not a member or associate member of Council, which in the judgment of the Council merits this distinction.

Test Navy Yard Dry Dock.—The 1,000-foot dry dock at the Philadelphia Navy Yard, known as No. 3, was flooded February 15, as a test, preparatory to being put into commission March 1. There is about 100 feet of earth between the end of the dock, as it now stands, and the Delaware river. This is to be dredged away and the gates connecting the dock with the river will be placed within the next two weeks.

New Motorship *San Miguel*, Built for the Thoreson Line, Christiania

Motorship Building in Europe

BY OUR SPECIAL LONDON CORRESPONDENT

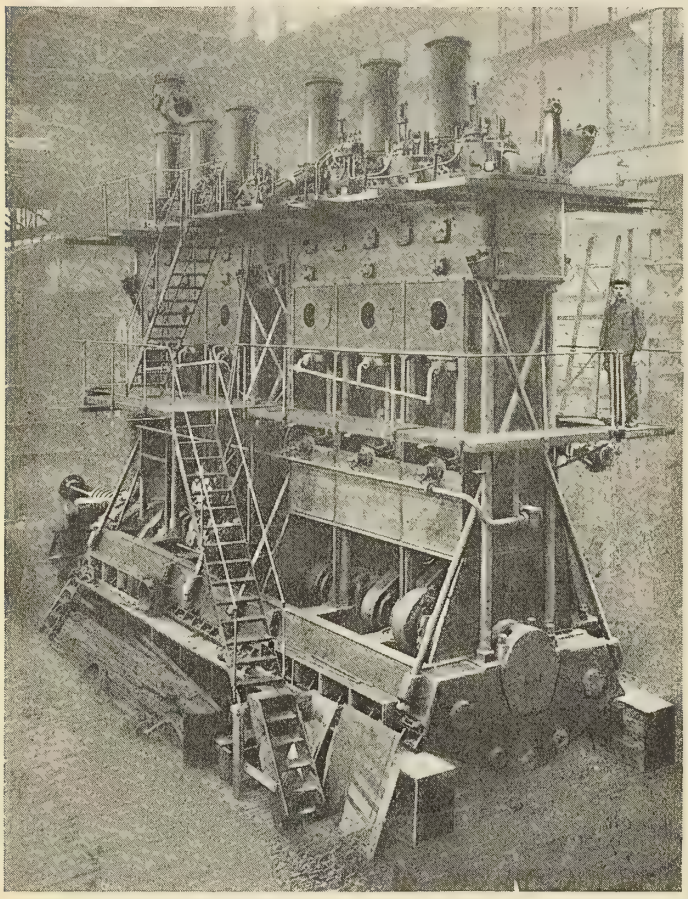
It might be thought that the recent fall in the price of bunker coal in Great Britain would give a setback to the motorship movement. This is not the case, for it is the general opinion of British shipowners that the prices of coal and liquid fuel will move to some extent in unison and that whatever fluctuations take place the Diesel ship will always show a marked saving over the corresponding steamer. Already the price of liquid fuel in English ports has fallen between £2 and £3 per ton, and it must of course be remembered that the respective costs of coal and oil in Europe are no criterion of the relative running expenses of steamships and motorships, since it is always arranged that the latter shall take on fuel at some ports on their route where the price is lowest. This is one of the inestimable advantages of the motorship due to its large radius of action.

MANY interesting motorships have been launched during the past month. Among those which were completed were the *Glenapp,* a notable addition to the already large fleet of motor vessels owned by the Glen Line, while another vessel for the same company, the *Glenbeg,* was launched, making the fourth 500-foot cargo vessel owned by the Glen Line. The *Lobos,* a 10,000-ton freighter, was completed for the Pacific Steam Navigation Company to trade between Glasgow, New York and the west coast of South America through the Panama Canal. She is the second of six motorships for the Pacific Steam Navigation Company, the other four being well under way.

A third vessel recently completed is one of a type rapidly gaining in favor with Scandinavian shipowners, namely, a vessel of about 3,000 tons. She is equipped with two Polar Diesel engines of the two cycle type, each developing 500 horsepower, but it must be admitted that the installation of two engines in such a small vessel is a somewhat costly proceeding. It is now more usual to fit vessels up to 3,000 or 4,000 tons with a single engine, and examples of this policy are given in the recent launches of the motorship *Sevilla* and *Sardinia* on the Tyne and in Holland respectively, both for Norwegian shipowners. The machinery of these two latter ships is worthy of reference. It is of the Werkspoor type, which is now being widely adopted by all classes of shipowners, partly on account of its simplicity and partly because it is probably the cheapest type now constructed. In the first named ship, which only carries about 2,500 tons, a 1,400-horsepower engine is installed, while in the second one of 2,140 horsepower is fitted, a departure from the standard 1,400-horsepower sets, of which probably twenty examples have been built or are approaching completion. It is by this standardization that the Werkspoor Company has been able to bring down the net manufacturing costs, and they are now comparable with those of corresponding steam machinery instead of being at least 25 percent above, which is the normal price for most Diesel plants.

With the development of a 2,140-horsepower engine the Werkspoor Company is now approaching the Burmeister and Wain firm in maximum cylinder output. These new Werkspoor engines are of the six cylinder type, and an eight cylinder motor of the same class would develop approximately

3,000 indicated horsepower against 3,200 indicated horsepower in eight cylinders, which represents the largest engine built to the Burmeister and Wain design. Most engineers on seeing the Werkspoor Diesel engine for the first time are inclined to say that its scantlings are too light for the pressures involved, but experience has shown this view to be incorrect. Unlike any other large marine oil engine, the construction comprises units of three cylinders in one casting, with the liners let into this casting which is supported by vertical steel stanchions of small dimensions. The cylinder covers are then bolted onto the casting and the whole design is thus of the utmost simplicity, while the cylinder cooling arrangements are obviously exceedingly good. No difficulties have been encountered in engines up to 1,400 indicated horsepower, and it will be of the greatest interest to engineers to note the results achieved with the larger motors. The builders' confidence in them is evidenced by their willingness to fit them in single screw ships, where reliability is even of greater importance than it is in twin screw vessels.



A 2,140-Horsepower Werkspoor Four-Cycle Engine Being Erected. This is the Largest of Its Type Yet Built

The question of the installation of oil engines in liners is now exercising the closest attention of the large European passenger shipowning companies, and although orders for nearly all classes of vessels have now ceased, it is likely that when prices have dropped and contracts are renewed many shipowners will build passenger motor liners. In the meantime, the Italian Transatlantic Company, undeterred by the present slump, has contracted for three motor passenger liners for service between Italy and the United States. These ships, which carry only a small amount of cargo, have accommodation for 350 passengers and present a very unusual appearance, having no funnel. The engine room is arranged amidships, and it is stated that a very large additional space has been rendered available for cabins on account of the difference in the size of Diesel machinery and corresponding steam plant. They will not be high-powered craft, as the machinery consists of two 2,000 brake horsepower Ansaldo Diesel engines (giving a combined indicated horsepower of about 5,500), but it is anticipated that a speed of 13 knots will be attained.

The employment of two cycle Diesel motors for these passenger liners is of some interest in view of the controversy raging regarding the respective advantages of two and four stroke plants. The Ansaldo two cycle engines on the three ships *Ansaldo San Giorgio I*, *Ansaldo San Giorgio II* and *Ansaldo San Giorgio III* which are now in commission have given exceptionally good service, and the system adopted of controlled port scavenging, which is peculiar to this type of motor, appears to have solved one of the most troublesome problems in two cycle Diesel engine designs. In England the two cycle engine seems to be gaining in favor, and the latest firm to take up Diesel manufacture, the well-known Wallsend Slipway and Engineering Company, decided after careful investigation that the Sulzer two cycle motor offered the greatest possibilities. It is an interesting fact that there are now more firms engaged upon the manufacture of two cycle motors in Great Britain than of the four cycle class.

The three motor passenger liners for the Italian Transatlantic Company will not be the first passenger vessels equipped with oil engines to be completed. This honor will fall to the motorship *Magvana,* which was launched two or three weeks ago on the Clyde for the British India Steam Navigation Company, and which is due for completion early in the spring. She and her two sister vessels now being built are designed to carry 150 passengers, and these are therefore more in the nature of mixed cargo and passenger vessels than pure passenger liners. It may be added that important progress towards the construction of oil engine driven transatlantic liners is anticipated, for the Cunard Company is greatly interested and John Brown & Company, the Clydebank shipbuilders, are now engaged upon the construction of Cammell Laird engines with the ultimate object of their installation in large liners.

Other interesting developments may be expected from some of the more important shipbuilding firms in the very near future, including Scotts Shipbuilding Company, which is manufacturing Still combined steam and oil engines; Armstrong Whitworth & Company, which is building its first Sulzer Diesel engines, and Dunsmuir and Jackson, who are manufacturing Cammellaird-Fullagar sets. So intense is the interest in motor shipbuilding in Great Britain at the present time that it may fairly be said that there is scarcely a shipbuilding firm of any importance which is not very actively engaged in the new industry. The whole trend of feeling is that as soon as the present depression passes there will be such a boom in shipbuilding as even the most optimistic scarcely thought to be possible a year or two back.

British Tonnage Lost During the War.—The Board of Trade, London, has just issued a report regarding the shipping casualties and loss of life occasioned to merchant shipping registered in the United Kingdom, the British Dominions, Colonies, Protectorates, and in India, which occurred in or near the costs of the United Kingdom during the period from July 1, 1914, to December 31, 1918. The number of vessels lost by marine casualty was 915 of a gross tonnage of 1,048,498, while those lost by enemy action amounted to 3,781 with a gross tonnage of 8,363,777, making a total loss of 4,696 vessels of a gross tonnage of 9,412,275. Of the total losses to British registered merchant and fishing vessels during the period of the war 80.52 percent of the number and 88.86 percent of the gross tonnage were losses due to enemy action. The total number of deaths of seamen, fishermen and passengers including prisoners of war is reported as 40,860.

How the Shipping Board Can Economize!

Costs of Fuel and Repairs on Shipping Board Vessels—An Opportunity for Efficiency Experts

BY "OLD SCOTCH"

IN a previous article on the subject of Economy (now a very popular theme with all who are attempting to run ships at existing freight rates and generally depressed business conditions) it was pointed out that the two items of expense where the greatest cuts could be made were in fuel and repairs. This statement was made from general knowledge, without any specific information concerning the relative costs of these important items as incurred in the operation of the Shipping Board's mammoth fleet.

Cost of Operating Shipping Board Vessels

Since that statement was made the Chief of Operations of the Board has appeared before the Walsh committee and summarized the total cost of operations as follows:

Fuel	43 percent
Repairs	30 percent
Wages and overtime	15 percent
Subsistence	4 to 5 percent
Deck and engine stores	6 to 7 percent
Total	100 percent

Of course it will at once be seen that in presenting these percentages of cost of operation, the principal items, namely, depreciation, capital cost and insurance, were neglected, as it is not customary to include them in estimating the expense of operating government-owned vessels. With privately-owned vessels, however, such charges are acutely present and cannot be neglected. It is the custom, based on actual costs, to estimate these three items as 50 percent of the total cost of operating privately-owned ships.

To arrive at the relative expense of maintaining the Board's vessels on a private ship basis, we must, therefore, take the cost of fuel at 21½ percent and the cost of repairs at 15 percent. On the same basis the cost of all wages and overtime will be but 7½ percent, which shows what a small proportion is actually paid to the men comprising the crews of our ships. To the pessimists concerning the ultimate success of our merchant marine, it will be seen that too much stress is placed on the disparity between the wages paid on American ships and those paid to the crews of our rivals. Captain Foley, the Chief of Operations, makes the bold statement that with a proper system of furnishing fuel to American-owned vessels, which he claims can result in saving one-half the cost now paid by our foreign rivals, no further subsidy need be given to our ships to permit them to compete successfully with our rivals. While many experienced ship operators will doubt the accuracy of this statement, and attribute it to ultra optimism, it is certainly worthy of serious consideration, coming from a reliable official, as it does, who has figures to substantiate his statement.

Fuel for the Oil-Burners

On the basis of tonnage, he further states that 80 percent of the government-owned ships are oil burners. We all know that one of the most constructive acts of the Shipping Board has been to locate large fuel oil stations at various ports of the world, where large numbers of American ships call. These stations are supplied with oil by Government tankers, the fuel purchased directly from the producers at the lowest market rates obtainable. The system of distribution is not yet complete, but from experience already gained with the stations in operation, it can quite readily be demonstrated that Captain Foley's claims regarding reductions in the cost are well substantiated.

The Government could and should go a step further in this most praiseworthy undertaking. Although nearly all known oil lands have been taken up from the public domain by private producers, there are still available thousands of acres of public lands containing oil shales. Congress should therefore at once set aside a large area of these lands for the benefit of the merchant marine, to be used when the cost of production of fuel oil from shale equals the cost of fuel oil in its natural state. From the best information obtainable that time is rapidly approaching. Here then we would have the utilization of one of our great natural resources for the benefit of the public at large, through the medium of providing fuel for the American merchant marine.

Economical Use of Fuel

Of almost equal importance to obtaining fuel oil at a low cost is economy in its use aboard ship. Oil-burning ships are comparatively modern, as the system for marine use is practicaly a development of the last decade. American-owned ships have had more experience with this type of fuel than the ships of any other nation, so in this matter at least we are in the vanguard. Oil-burning devices are practically American inventions, as the best of them have been developed and used first in this country. The United States Navy has done much in this development, as our war vessels were the first to adopt this ideal system of steam generation. Hundreds of firemen have been hastily drilled in the art of oil burning to meet the great demands of our rapidly constructed fleet of merchant vessels. To those familiar with the burning of oil as fuel, it is known how readily it can be wasted by carelessness and ignorance on the part of those who manipulate the relative supplies of oil and air to the burners. I think it will not be disputed that at least ten percent of the oil burned on our whole Shipping Board fleet is wasted on account of the lack of skill or carelessness of the men in charge.

Efficiency Experts Needed

The Shipping Board should as soon as possible establish a corps of efficiency experts, and send at least one on each of its operating ships. These men should be carefully selected from young technical graduates, and appointed solely on the basis of their merit and training for the job in hand. Each ship should be furnished with a pyrometer for taking stack temperatures, and with apparatus for analyzing the products of combustion. Five hundred dollars would be ample to supply each ship with all necessary equipment of this kind.

Think of the savings that can be brought about! The estimated cost of oil fuel alone for the Shipping Board fleet for one year is over one hundred million dollars. An investment of say two million dollars for efficiency experts and scientific apparatus will save ten million dollars a year, on a basis of ten percent saving in fuel oil consumed during that period. This is no wild dream, but a very conservative estimate of what can be expected, if this scheme is properly carried out.

I am an old timer myself, and appreciate full well that the tendency of the old-time engineer is to pooh! pooh! any sug-

gestion of this kind. When I first went to sea, if I should have even hinted at such a revolutionary step, I would probably have been clouted over the head with the nearest grate-bar that wasn't working. I can almost hear the howls of "Cut out that highbrow chatter! Wot do them guys know about practical steamboating?"

Ah, my old-time friends, times have changed, and if you haven't kept pace with these scientific developments in burning fuel, you are very soon going to the scrap heap. I have been shown what can be done by the application of these scientific methods, and, after all, science is nothing more nor less than the application of good, ordinary common sense. Let me advise you sea-going boys, young and old, that if any of those "highbrows" should come aboard your ship to show you how to squeeze the most B. T. U.'s out of the oil fuel, don't make the mistake of guying them, if, perhaps, for the first two or three days they get white around the gills from seasickness. Honey up to them and pump them for information as to how they get the "dope" from the machines as to how much CO_2 you are shooting up the stack. Learn all you can from them and put in practice what you learn—it will not only make your own job more secure, but you will be helping to solve the problem of how to keep our Yankee ships on the seas in competition with the "Limies" and the "Japs." They're all good fellows, but no better than you are when you really get down to business.

Current Shipping Board Expenditures Will Influence Merchant Marine Policy

BY WALDON FAWCETT

WHETHER the protracted investigation by a special committee of Congress of the war-time record of the United States Shipping Board and Emergency Fleet Corporation will have any permanent, tangible influence upon the nation's future merchant marine policy is open to doubt. There is, however, a factor in current history in this quarter that is bound to sway Congressional and Governmental sentiment in months and years to come. Muck raking by a group of inquisitors representing the lower house of Congress may serve no better end than to provide a sensation for the newspapers. But the survey made this past few weeks by the Appropriations Committee of the House of Representatives, covering the current and prospective expenditures of the Shipping Board, may be counted upon to find reaction in the policy of the future with respect to the government-owned merchant marine.

The explanation of this contact is not far to seek. It lies in the fact that, henceforth, all phases of United States public policy will be subject in marked degree to considerations of expense. Facing, on the one hand, the requirements of an executive institution the upkeep of which necessitates an annual budget of $4,000,000,000, and, on the other hand, the insistent demands of the public for a reduction of taxes, the national law-making body must essay economy, however unbalanced the effort. We see one manifestation of this impulse to thrift in the agitation in Congress for reduction of naval armaments. A less spectacular but more momentus sequel will come with the trimming of the Federal merchant marine policy to fit the financial cloth.

Prospective Retrenchment

How quickly the menace of prospective retrenchment has been communicated to the shipbuilding centers of the country has been attested by the promptness with which delegations of shipyard workers and business men of shipbuilding communities have appeared at Washington to protest against interruption of the Shipping Board's uncompleted construction programme. While recognizing the need and propriety of the utmost conservatism in governmental expenditures, the spokesmen for the petitioners have urged that it would be a poor economy to halt work abruptly on vessels that are in various stages of completion from 40 percent up, as are those, for example, at the Camden yard of the New York Shipbuilding Corporation.

It was, by the by, in comment upon the submission of a petition signed by 9,000 Delaware River shipyard workers, that the head of the Appropriation's Committee at the Capitol made a statement that gives a broad hint of the Congressional attitude on future governmental participation in the merchant marine. Said Chairman Good: "The Committee has been impressed with the fact that during the war the wages of employees were necessarily increased in order to meet the rapidly increasing cost of living. Perhaps in no single industry were the wages increased more than in the shipbuilding industry, and that was necessary in order to speed up the shipbuilding programme.

Ships Being Constructed at a Loss

"The war is now over and every ship, except the tankers, that the government is getting now and putting into commission means a loss to the government. The tankers are the one exception. Of course, looking at the matter in a broad way, the government does not want to see a man out of employment in the United States who wants to work, if that is possible; at the same time here are contracts, many of which were made on a cost-plus basis or a cost-plus-fee basis, and with industries all over the country reducing wages all the way from 10 to 25 percent, and even a greater percentage, and with quite a substantial reduction being effected in retail prices of clothing and of all food products, it has seemed to the committee that it is only fair that we should do one of two things, we either ought to slow up in this building programme and not crowd it as it has been crowded, because the ships we are getting are operated at a loss, or there ought to be a substantial reduction somewhere in the cost of the government."

Necessity for Wage Reductions

The head of the Appropriation's Committee went on to point out to the assembled shipbuilding representatives and to the group of Congressmen, who are charged with the responsibility of allotting government funds that a huge deficit stares the government in the face. Confronted by an empty treasury, the $95,000,000 asked to be made immediately available to carry on the programme of the Shipping Board appeared, as the chairman put it, "a good deal of money." When it was called to his attention that the rank and file of shipyard workers on the Delaware were amenable to a readjustment of wages, feeling that a reduction was preferable to enforced idleness, he commended their spirit. Unless a policy of wage readjustment be promptly carried out he predicted that by July or August, the shipyards would be

closed and the men out of work, since private interests, no more than the government, could afford to place contracts at prices predicated on the war-time wage scales.

It has been revealed in the discussions at Washington that in shipbuilding districts, such as the Delaware River territory, where the shipyard employees are purchasing the houses in which they reside, the desire to complete payments upon these homes is proving a potent factor in reconciling the men to wage reductions, in lieu of a risk of loss of employment. In order to save their homes, the men are represented as content to conform to any reasonable readjustment of government contracts and likewise to accept wage scales for private contracts that may enable the shipbuilding companies to obtain contracts for private tonnage after the completion of government contracts in the late summer or early autumn. In this same connection, certain well-wishers of the shipbuilding industry are urging that the government should not longer delay the sale to the workers of the dwellings erected under the war-time housing programme, a considerable proportion of which are yet held by the Shipping Board. It is estimated that in the Philadelphia district there is not less than $10,000,000 tied up in houses that might have been sold long ago to the shipyard workers who occupy them. A progressive school of thought that has lately found expression at Washington holds that an effort should be made without further delay to dispose to the occupants all the dwellings erected by the United States Housing Corporation.

Unpaid Bills

The shipbuilding and vessel outfitting interests of the country have, aside from their general interest in the future policy of the government as regards its merchant marine, an immediate concern for the provision of supplementary funds to meet current needs. Scores of firms have past-due claims upon which payment is in arrears; that is to say, there were unpaid, awaiting the appropriation of funds by the 66th Congress, audited vouchers issued by the Division of Construction of the Shipping Board Emergency Fleet Corporation that total more than $14,000,000. Included in this muster of unpaid bills that are past due are items of nearly $2,500,000 due William Cramp & Sons Ship and Engine Building Company, $2,775,000 due the New York Shipbuilding Corporation, nearly half a million dollars due the Baltimore Dry Docks and Shipbuilding Company, and more than that due the Los Angeles Ship Building Company, upward of half a million dollars owing the Newport News Ship Building and Dry Dock Company, and upward of $2,000,000 to the credit of the Bethlehem Shipbuilding Corporation, Ltd.

Money Owing the Shipping Board

Financial embarrassment of the Shipping Board is in part due to the unfortunate aftermath of its ship sale programme. The Board is being required to take back some of the tonnage that it supposed it had sold and a considerable proportion of the amount due for the sale of ships remains unpaid. Indeed, at the opening of the year 1921, the amounts overdue on ship sales aggregated $11,800,000, and the General Comptroller of the Shipping Board, Mr. Alonzo Tweedale, stated that he did not believe that any but a very small proportion of these overdue accounts will be paid. The purchasers of the ships are apparently solvent, he has reported, but by reason of the financial stringency are unable to pay. The situation is further complicated by the fact that some of the deferred notes are due from foreigners and it is provided in the sale agreement that unless the franc falls below 10 to the dollar there are to be granted at least two extensions of these notes. This circumstance has operated to defer payment of a part of the $11,800,000. In the interval between January 1 and June 30, there is due the Shipping Board on the sale of ships an aggregate of $20,000,000, but officials of the Board who have canvassed the situation have stated confidentially that they do not expect to receive more than $10,000,000 of this sum.

A situation but little more encouraging to Shipping Board finances exists with respect to the sum due from the sale of property other than ships, notably salvaged shipbuilding plants and equipment. On surplus salvaged material there is due by June 30 of this year, a total of $13,500,000, but the most optimistic official at the offices of the Shipping Board does not forecast 100 percent collection on these obligations. Payment of 75 percent of the amount due seems to be the measure of the most sanguine expectations. Shipping Board finances have been complicated because of disputes between the Board and the War Department, pending the decision of which the War Department has withheld the payment of millions of dollars claimed to be due for vessels furnished for army transport service. This tangle, which might appear on the surface merely an administrative clash between two branches of the government, has no little interest for private shipbuilding and shipowning interests because many of the items on which payment is in dispute were occasioned by the repair and reconstruction work necessary ere vessels requisitioned for war service could be turned back, in promised condition, to private owners.

Current Costs of Government Ship Operation

Scrutiny of current operations of the Shipping Board precipitated by the demand for a *deficiency* appropriation of upward of $100,000,000, has resulted, to the ultimate enlightenment of maritime circles in illuminating revelations as to current costs of government ship operation. The Board is operating through agencies or through operators a total of more than one thousand ships of which 79 are tankers and the remainder are passenger and cargo ships. From the operation of these ships during the last half of 1920, the Shipping Board received an income of $23,489,000. This was gross and against it were charged operating expenses amounting to $22,300,000 and vessel repairs that footed up about $28,000,000. The falling off in freight rates and the difficulty of obtaining cargoes during the final three months of the year necessitated the taking of a loss in the operation of many of the ships.

In an effort to analyze the situation and ascertain just what conditions are, statisticians of the Shipping Board recently studied the record of operations since September 1 last. Computing the result of representative voyages, on all the various trade routes covered by Shipping Board operations, the investigators arrived at the conclusion that on an average the total loss for the operation of the government owned fleet under the present plan can be set down at $3,800,000 per month. That includes depreciation, maintenance, insurance and all other charges.

It should perhaps be made clear that in seeking the bitter truth the government statisticians did not compute on the full strength of the government-owned merchant fleet. Instead the survey covered 227 vessels. With the basic figures thus obtained worked out on the scale of deadweight tonnage for all the ships on the various trade routes there was calculated the total net loss per month. Shipping Board officials have intimated to Congressmen a belief that the losses of the government in the present dilemma are not out of line with those of private shipowners. It is contended that all private shipowners are to-day losing money in their operations.

Future Policy in Regard to Shipping Board Vessels

When the Appropriation's Committee at the Capitol was acquainted with the full proportions of the loss that the government is sustaining in the operation of the one thousand

(*Continued on page* 250.)

Measurement of Fuel Oil

BY J. D. GILMAN*

The tables given in this article have been compiled by the author for the use of chief engineers and the others interested in arriving at a correct amount of fuel oil that should be charged for by the oil companies when billing for fuel. The standard temperature being 60 degrees Fahrenheit or 15.6 degrees Centigrade, all fuel oil should be reduced to its volume at this temperature.

FUEL oil used for firing boilers is measured on the West coast of the United States by the 42-gallon barrel containing 9,702 cubic inches or 5.6145 cubic feet. In other parts of the world the long ton of 2,240 pounds is used. In English ports the long ton of 2,240 pounds, with the subdivisions of the hundredweight of 112 pounds, the quarter of 28 pounds and the pound, is usually used.

In buying and using fuel oil the usual standard is 60 degrees Fahrenheit or 15.6 degrees Centigrade, and the amount is corrected to what it would be at this standard temperature to arrive at the exact amount.

Where the barrel is used as the measure, only one correction is necessary, that of the expansion, and as the ordinary fuel expands about .0004 in volume for each degree Fahrenheit and about .00703 for each degree Centigrade, the corrected amount can readily be found by the use of Table I, where the temperature is taken in Fahrenheit degrees, and Table II, where the temperature is taken in Centigrade degrees. The figures given in these tables are multipliers, and if the amount of oil under consideration is multiplied by the decimal shown opposite its temperature, the product will be the net amount of oil at the standard temperature. This is the correct amount that should be charged.

Where the ton of 2,240 pounds is used as the measure to arrive at the correct amount, additional calculations are necessary. It is usual, and should be demanded, that the cubic feet, degrees Baume or specific gravity, and the temperature be furnished, so that a check can be made of the amount charged. Having the cubic feet and temperature, the volume at the standard 60 degrees Fahrenheit or 15.6 degrees Centigrade can easily be found by Table I or Table II, depending upon which thermometer is used.

The specific gravity of the oil also changes with the temperature, and Table III gives a correction factor that must be added to the observed specific gravity, if the temperature is above the standard, and subtracted if the temperature is below the standard; when this is done the correct specific gravity will be found, to use in finding the weight of the oil under consideration.

Having the corrected volume of the oil and the cor-

* Port engineer, Pacific Steamship Company, Seattle, Wash.

TABLE I.—Temperature Correction Table for Fahrenheit Thermometer.

Degrees F	Net-Gross Multiplied By	Degrees F	Net-Gross Multiplied By	Degrees F	Net-Gross Multiplied By	Degrees F	Net-Gross Multiplied By	Degrees F	Net-Gross Multiplied By
40	1.00806	75	.994036	110	.980392	145	.967118	180	.954198
41	1.00766	76	.993641	111	.980008	146	.966744	181	.953834
42	1.00725	77	.993246	112	.979624	147	.966370	182	.953471
43	1.00685	78	.992851	113	.979240	148	.965997	183	.953107
44	1.00644	79	.992457	114	.978857	149	.965624	184	.952744
45	1.00604	80	.992063	115	.978474	150	.965251	185	.952381
46	1.00563	81	.991670	116	.978091	151	.964878	186	.952018
47	1.00523	82	.991277	117	.977708	152	.9 4506	187	.951656
48	1.00482	83	.990884	118	.977326	153	.964134	188	.951294
49	1.00442	84	.990491	119	.976944	154	.963763	189	.950932
50	1.00402	85	.990099	120	.976563	155	.963391	190	.950570
51	1.00361	86	.989707	121	.976181	156	.963020	191	.950209
52	1.00321	87	.989315	122	.975800	157	.962649	192	.949848
53	1.00281	88	.988924	123	.975419	158	.962279	193	.949487
54	1.00241	89	.988533	124	.975039	159	.961908	194	.949127
55	1.00200	90	.988142	125	.974659	160	.961538	195	.948767
56	1.00160	91	.987752	126	.974279	161	.961169	196	.948407
57	1.00120	92	.987362	127	.973900	162	.960799	197	.948047
58	1.00080	93	.986972	128	.973520	163	.960430	198	.947688
59	1.00040	94	.986582	129	.973141	164	.960061	199	.947329
60	1.00000	95	.986193	130	.972763	165	.959693		
61	.999600	96	.985804	131	.972384	166	.959325		
62	.999201	97	.985416	132	.972006	167	.958957		
63	.998801	98	.985028	133	.971628	168	.958589		
64	.998403	99	.984640	134	.971251	169	.958222		
65	.998004	100	.984252	135	.970874	170	.957854		
66	.997606	101	.983865	136	.970497	171	.957488		
67	.997208	102	.983478	137	.970120	172	.957121		
68	.996810	103	.983091	138	.969744	173	.956755		
69	.996413	104	.982704	139	.969368	174	.956389		
70	.996016	105	.982318	140	.968992	175	.956023		
71	.995619	106	.981932	141	.968617	176	.955658		
72	.995223	107	.981547	142	.968242	177	.955292		
73	.994827	108	.981162	143	.967867	178	.954927		
74	.994431	109	.980777	144	.967492	179	.954563		

TABLE II.—TEMPERATURE CORRECTION TABLE FOR CENTRIGRADE THERMOMETER.

Degrees C.	Net-Gross Multiplied By	Degrees C.	Net-Gross Multiplied By	Degrees C.	Net-Gross Multiplied By
5	1.0076600	35	.9861930	65½	.96528950
5½	1.0072960	35½	.9858441	66	.96495500
6	1.0069320	36	.9854952	66½	.96462050
6½	1.0065680	36½	.9851463	67	.96428600
7	1.0062040	37	.9847974	67½	.96395150
7½	1.0058400	37½	.9844485	68	.96361700
8	1.0054760	38	.9840996	68½	.96328250
8½	1.0051120	38½	.9837507	69	.96294800
9	1.0047480	39	.9834018	69½	.96261350
9½	1.0043840	39½	.9830529	70	.96227900
10	1.0040200	40	.9827040	70½	.96194680
10½	1.0036580	40½	.9823576	71	.96161460
11	1.0032960	41	.9820112	71½	.96128240
11½	1.0029340	41½	.9816648	72	.96095020
12	1.0025720	42	.9813184	72½	.96061800
12½	1.0022100	42½	.9809720	73	.96028580
13	1.0018480	43	.9806256	73½	.95995360
13½	1.0014860	43½	.9802792	74	.95962140
14	1.0011240	44	.9799328	74½	.95928920
14½	1.0007620	44½	.9795864	75	.95895700
15	1.0004000	45	.9792400	75½	.95862710
15½	1.0000410	45½	.9788960	76	.95829720
15.6	1.0000000	46	.9785520	76½	.95796730
16	.9996820	46½	.9782080	77	.95763740
16½	.9993230	47	.9778640	77½	.95730750
17	.9989640	47½	.9775200	78	.95697760
17½	.9986050	48	.9771760	78½	.95664770
18	.9982460	48½	.9768320	79	.95631780
18½	.9978870	49	.9764880	79½	.95598790
19	.9975280	49½	.9761440	80	.95565800
19½	.9971690	50	.9758000	80½	.95533030
20	.9968100	50½	.9754584	81	.95500260
20½	.9964536	51	.9751168	81½	.95467490
21	.9960972	51½	.9747752	82	.95434720
21½	.9957408	52	.9744336	82½	.95401950
22	.9953844	52½	.9740920	83	.95369180
22½	.9950280	53	.9737504	83½	.95336410
23	.9946716	53½	.9734088	84	.95303640
23½	.9943152	54	.9730672	84½	.95270870
24	.9939588	54½	.9727256	85	.95238100
24½	.9936024	55	.9723840	85½	.95205560
25	.9932460	55½	.9720448	86	.95173020
25½	.9928921	56	.9717056	86½	.95140480
26	.9925382	56½	.9713664	87	.95107940
26½	.9921843	57	.9710272	87½	.95075400
27	.9918304	57½	.9706880	88	.95042860
27½	.9914765	58	.9703488	88½	.95010320
28	.9911226	58½	.9700096	89	.94977780
28½	.9907687	59	.9696704	89½	.94945240
29	.9904148	59½	.9693312	90	.94912700
29½	.9900609	60	.9689920	90½	.94880380
30	.9897070	60½	.9686552	91	.94848060
30½	.9893556	61	.9683184	91½	.94815740
31	.9890042	61½	.9679816	92	.94783420
31½	.9886528	62	.9676448	92½	.94751100
32	.9883014	62½	.9673080	93	.94718780
32½	.9879500	63	.9669712	93½	.94686460
33	.9875986	63½	.9666344	94	.94654140
33½	.9872472	64	.9662976	94½	.94621820
34	.9868958	54½	.9659608	95	.94589500
34½	.9865444	65	.9656240		

TABLE III—OBSERVED SPECIFIC GRAVITY.

Observed Temp. C.	0.650	0.700	0.750	0.800	0.850	0.860	0.870	0.880	0.890	0.900	0.910	0.920	0.930	0.940	0.950	0.960
Subtract From Observed Specific Gravity.																
1.	.01596	.01490	.01383	.01280	.01170	.01140	.01120	.01100	.01080	.01064	.01064	.01064	.01064	.01064	.01064	.01064
.5	.01550	.01440	.01346	.01240	.01135	.01110	.01090	.01070	.01050	.01032	.01032	.01032	.01032	.01032	.01032	.01032
0.	.01500	.01400	.01300	.01200	.01100	.01080	.01060	.01040	.01020	.01000	.01000	.01000	.01000	.01000	.01000	.01000
.5	.01450	.01360	.01250	.01160	.01065	.01050	.01030	.01010	.00990	.00970	.00970	.00970	.00970	.00970	.00970	.00970
1.	.01400	.01310	.01220	.01120	.01030	.01020	.01000	.00980	.00960	.00940	.00940	.00940	.00940	.00940	.00940	.00940
1.5	.01350	.01260	.01170	.01080	.00990	.00970	.00950	.00930	.00910	.00900	.00900	.00900	.00900	.00900	.00900	.00900
2	.01300	.01220	.01130	.01040	.00960	.00950	.00920	.00910	.00890	.00870	.00870	.00870	.00870	.00870	.00870	.00870
2.5	.01260	.01170	.01090	.01000	.00920	.00900	.00880	.00860	.00850	.00840	.00840	.00840	.00840	.00840	.00840	.00840
3.	.01210	.01130	.01050	.00970	.00890	.00870	.00850	.00840	.00820	.00800	.00800	.00800	.00800	.00800	.00800	.00800
3.5	.01160	.01090	.01010	.00930	.00850	.00830	.00820	.00810	.00790	.00770	.00770	.00770	.00770	.00770	.00770	.00770
4.	.01120	.01050	.00960	.00890	.00820	.00800	.00780	.00770	.00760	.00740	.00740	.00740	.00740	.00740	.00740	.00740
4.5	.01070	.01000	.00920	.00850	.00780	.00760	.00740	.00730	.00720	.00710	.00710	.00710	.00710	.00710	.00710	.00710
5.	.01020	.00950	.00880	.00810	.00750	.00730	.00710	.00700	.00690	.00680	.00680	.00680	.00680	.00680	.00680	.00680
5.5	.00970	.00910	.00830	.00770	.00720	.00710	.00690	.00670	.00660	.00650	.00650	.00650	.00650	.00650	.00650	.00650
6.	.00920	.00860	.00800	.00740	.00680	.00670	.00650	.00630	.00620	.00610	.00610	.00610	.00610	.00610	.00610	.00610
6.5	.00870	.00820	.00760	.00700	.00640	.00630	.00610	.00600	.00590	.00580	.00580	.00580	.00580	.00580	.00580	.00580
7.	.00830	.00770	.00720	.00660	.00610	.00600	.00590	.00580	.00570	.00550	.00550	.00550	.00550	.00550	.00550	.00550
7.5	.00780	.00730	.00670	.00620	.00570	.00560	.00550	.00540	.00530	.00520	.00520	.00520	.00520	.00520	.00520	.00520
8.	.00730	.00680	.00630	.00580	.00540	.00530	.00520	.00510	.00500	.00480	.00480	.00480	.00480	.00480	.00480	.00480
8.5	.00680	.00640	.00590	.00540	.00500	.00490	.00480	.00470	.00460	.00450	.00450	.00450	.00450	.00450	.00450	.00450
9	.00630	.00590	.00550	.00500	.00470	.00460	.00450	.00440	.00430	.00420	.00420	.00420	.00420	.00420	.00420	.00420
9.5	.00590	.00550	.00500	.00470	.00430	.00430	.00420	.00410	.00400	.00390	.00390	.00390	.00390	.00390	.00390	.00390
10	.00540	.00500	.00460	.00430	.00400	.00400	.00390	.00380	.00370	.00360	.00360	.00360	.00360	.00360	.00360	.00360
10.5	.00490	.00450	.00420	.00390	.00370	.00370	.00360	.00350	.00340	.00330	.00330	.00330	.00330	.00330	.00330	.00330
11	.00440	.00410	.00380	.00350	.00330	.00330	.00320	.00310	.00310	.00300	.00300	.00300	.00300	.00300	.00300	.00300
11.5	.00390	.00370	.00340	.00310	.00290	.00280	.00280	.00270	.00270	.00260	.00260	.00260	.00260	.00260	.00260	.00260
12.	.00340	.00320	.00300	.00270	.00250	.00250	.00250	.00240	.00240	.00230	.00230	.00230	.00230	.00230	.00230	.00230
12.5	.00300	.00280	.00260	.00240	.00220	.00220	.00220	.00210	.00210	.00200	.00200	.00200	.00200	.00200	.00200	.00200
13.	.00250	.00230	.00220	.00200	.00180	.00180	.00180	.00170	.00170	.00170	.00170	.00170	.00170	.00170	.00170	.00170
13.5	.00200	.00190	.00170	.00160	.00150	.00150	.00150	.00140	.00140	.00130	.00130	.00130	.00130	.00130	.00130	.00130
14.	.00150	.00140	.00130	.00120	.00110	.00110	.00110	.00100	.00100	.00100	.00100	.00100	.00100	.00100	.00100	.00100
14.5	.00100	.00090	.00090	.00080	.00080	.00080	.00080	.00070	.00070	.00064	.00064	.00064	.00064	.00064	.00064	.00064
15.	.00060	.00050	.00050	.00046	.00040	.00040	.00040	.00040	.00040	.00038	.00038	.00038	.00038	.00038	.00038	.00038
15.6	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
ADD TO OBSERVED SPECIFIC GRAVITY TO GIVE TRUE SPECIFIC GRAVITY AT 60°/60° F or 15.6° C.																
16.	.00036	.00032	.00030	.00028	.00025	.00025	.00025	.00024	.00024	.00024	.00024	.00024	.00024	.00024	.00024	.00024
16.5	.00080	.00070	.00060	.00060	.00050	.00050	.00050	.00050	.00050	.00050	.00050	.00050	.00050	.00050	.00050	.00050
17.	.00120	.00110	.00100	.00090	.00080	.00080	.00080	.00080	.00080	.00080	.00080	.00080	.00080	.00080	.00080	.00080
17.5	.00160	.00150	.00140	.00130	.00120	.00120	.00120	.00110	.00110	.00110	.00110	.00110	.00110	.00110	.00110	.00110
18.	.00210	.00190	.00180	.00160	.00150	.00150	.00150	.00140	.00140	.00140	.00140	.00140	.00140	.00140	.00140	.00140
18.5	.00260	.00230	.00210	.00200	.00180	.00180	.00180	.00170	.00170	.00170	.00170	.00170	.00170	.00170	.00170	.00170
19.	.00310	.00270	.00250	.00230	.00210	.00210	.00210	.00200	.00200	.00200	.00200	.00200	.00200	.00200	.00200	.00200
19.5	.00350	.00310	.00290	.00270	.00250	.00250	.00250	.00240	.00240	.00240	.00240	.00240	.00240	.00240	.00240	.00240
20.	.00400	.00350	.00330	.00300	.00270	.00270	.00270	.00270	.00270	.00270	.00270	.00270	.00270	.00270	.00270	.00270
20.5	.00440	.00390	.00360	.00340	.00300	.00300	.00300	.00300	.00300	.00300	.00300	.00300	.00300	.00300	.00300	.00300
21.	.00480	.00430	.00400	.00370	.00330	.00330	.00330	.00330	.00330	.00330	.00330	.00330	.00330	.00330	.00330	.00330
21.5	.00530	.00470	.00440	.00410	.00370	.00370	.00370	.00360	.00360	.00360	.00360	.00360	.00360	.00360	.00360	.00360
22.	.00570	.00510	.00480	.00440	.00400	.00400	.00400	.00390	.00390	.00390	.00390	.00390	.00390	.00390	.00390	.00390
22.5	.00610	.00550	.00510	.00480	.00430	.00430	.00430	.00420	.00420	.00420	.00420	.00420	.00420	.00420	.00420	.00420
23.	.00660	.00590	.00550	.00510	.00460	.00460	.00460	.00450	.00450	.00450	.00450	.00450	.00450	.00450	.00450	.00450
23.5	.00710	.00630	.00590	.00550	.00490	.00490	.00490	.00480	.00480	.00480	.00480	.00480	.00480	.00480	.00480	.00480
24.	.00750	.00670	.00630	.00580	.00520	.00520	.00520	.00510	.00510	.00510	.00510	.00510	.00510	.00510	.00510	.00510
24.5	.00800	.00710	.00660	.00620	.00550	.00550	.00550	.00540	.00540	.00540	.00540	.00540	.00540	.00540	.00540	.00540
25.	.00840	.00750	.00700	.00650	.00580	.00580	.00580	.00570	.00570	.00570	.00570	.00570	.00570	.00570	.00570	.00570
25.5	.00890	.00790	.00740	.00690	.00610	.00610	.00610	.00600	.00600	.00600	.00600	.00600	.00600	.00600	.00600	.00600
26.	.00930	.00830	.00780	.00720	.00650	.00650	.00640	.00640	.00630	.00630	.00630	.00630	.00630	.00630	.00630	.00630
26.5	.00980	.00870	.00810	.00760	.00680	.00680	.00670	.00670	.00660	.00660	.00660	.00660	.00660	.00660	.00660	.00660
27.	.01020	.00910	.00850	.00790	.00710	.00710	.00700	.00700	.00690	.00690	.00690	.00690	.00690	.00690	.00690	.00690
27.5	.01070	.00950	.00890	.00830	.00740	.00740	.00740	.00730	.00730	.00730	.00730	.00730	.00730	.00730	.00730	.00730
28.	.01110	.01000	.00930	.00860	.00770	.00770	.00770	.00760	.00760	.00760	.00760	.00760	.00760	.00760	.00760	.00760
28.5	.01160	.01030	.00960	.00900	.00800	.00800	.00800	.00790	.00790	.00790	.00790	.00790	.00790	.00790	.00790	.00790
29.	.01200	.01070	.01000	.00930	.00830	.00830	.00830	.00820	.00820	.00820	.00820	.00820	.00820	.00820	.00820	.00820
29.5	.01250	.01110	.01040	.00970	.00870	.00870	.00860	.00860	.00850	.00850	.00850	.00850	.00850	.00850	.00850	.00850
30.	.01300	.01160	.01080	.01000	.00900	.00900	.00890	.00890	.00880	.00880	.00880	.00880	.00880	.00880	.00880	.00880
30.5	.01340	.01200	.01110	.01040	.00930	.00930	.00920	.00920	.00910	.00910	.00910	.00910	.00910	.00910	.00910	.00910
31.	.01380	.01240	.01150	.01070	.00960	.00960	.00950	.00950	.00940	.00940	.00940	.00940	.00940	.00940	.00940	.00940
31.5	.01430	.01280	.01190	.01110	.00990	.00990	.00980	.00980	.00970	.00970	.00970	.00970	.00970	.00970	.00970	.00970
32.	.01470	.01320	.01230	.01140	.01020	.01020	.01010	.01010	.01000	.01000	.01000	.01000	.01000	.01000	.01000	.01000
32.5	.01520	.01360	.01260	.01180	.01050	.01050	.01040	.01040	.01030	.01030	.01030	.01030	.01030	.01030	.01030	.01030
33	.01560	.01400	.01300	.01210	.01080	.01080	.01070	.01070	.01060	.01060	.01060	.01060	.01060	.01060	.01060	.01060
33.5	.01610	.01440	.01340	.01250	.01110	.01110	.01170	.01100	.01090	.01090	.01090	.01090	.01090	.01090	.01090	.01090
34.	.01650	.01480	.01380	.01280	.01150	.01140	.01100	.01130	.01120	.01120	.01120	.01120	.01120	.01120	.01120	.01120
34.5	.01700	.01520	.01410	.01320	.01180	.01170	.01160	.01160	.01150	.01150	.01150	.01150	.01150	.01150	.01150	.01150
35.	.01740	.01560	.01450	.01350	.01210	.01200	.01190	.01190	.01180	.01180	.01180	.01180	.01180	.01180	.01180	.01180
35.5	.01790	.01600	.01490	.01390	.01240	.01230	.01220	.01220	.01210	.01210	.01210	.01210	.01210	.01210	.01210	.01210
36.	.01830	.01640	.01530	.01420	.01270	.01260	.01250	.01250	.01240	.01240	.01240	.01240	.01240	.01240	.01240	.01240
36.5	.01880	.01680	.01560	.01460	.01300	.01300	.01290	.01290	.01280	.01280	.01280	.01280	.01280	.01280	.01280	.01280
37.	.01920	.01720	.01600	.01490	.01330	.01330	.01320	.01320	.01310	.01310	.01310	.01310	.01310	.01310	.01310	.01310
37.5	.01970	.01760	.01640	.01530	.01370	.01360	.01350	.01350	.01340	.01340	.01340	.01340	.01340	.01340	.01340	.01340
38.	.02010	.01800	.01680	.01560	.01400	.01390	.01380	.01380	.01370	.01370	.01370	.01370	.01370	.01370	.01370	.01370
38.5	.02060	.01840	.01710	.01600	.01430	.01420	.01410	.01410	.01400	.01400	.01400	.01400	.01400	.01400	.01400	.01400
39.	.02100	.01880	.01750	.01630	.01460	.01450	.01440	.01440	.01430	.01430	.01430	.01430	.01430	.01430	.01430	.01430
39.5	.02150	.01920	.01790	.01670	.01490	.01480	.01470	.01470	.01460	.01460	.01460	.01460	.01460	.01460	.01460	.01460
40.	.02200	.01960	.01830	.01700	.01520	.01510	.01500	.01500	.01490	.01490	.01490	.01490	.01490	.01490	.01490	.01490
40.5	.02240	.02000	.01870	.01740	.01550	.01540	.01530	.01530	.01520	.01520	.01520	.01520	.01520	.01520	.01520	.01520
41.	.02280	.02040	.01900	.01770	.01580	.01570	.01560	.01560	.01550	.01550	.01550	.01550	.01550	.01550	.01550	.01550
41.5	.02330	.02080	.01940	.01810	.01620	.01610	.01600	.01590	.01580	.01580	.01580	.01580	.01580	.01580	.01580	.01580
42.	.02370	.02120	.01980	.01840	.01650	.01640	.01630	.01620	.01610	.01610	.01610	.01610	.01610	.01610	.01610	.01610
42.5	.02420	.02160	.02020	.01880	.01680	.01670	.01660	.01650	.01640	.01640	.01640	.01640	.01640	.01640	.01640	.01640
43.	.02460	.02200	.02050	.01910	.01710	.01700	.01690	.01680	.01680	.01670	.01670	.01670	.01670	.01670	.01670	.01670
43.5	.02510	.02240	.02090	.01950	.01740	.01730	.01720	.01710	.01700	.01700	.01700	.01700	.01700	.01700	.01700	.01700
44.	.02550	.02280	.02130	.01980	.01770	.01760	.01750	.01740	.01730	.01730	.01730	.01730	.01730	.01730	.01730	.01730
44.5	.02600	.02320	.02170	.02020	.01800	.01790	.01780	.01780	.01770	.01770	.01770	.01770	.01770	.01770	.01770	.01770
45.	.02640	.02360	.02200	.02050	.01830	.01820	.01810	.01810	.01800	.01800	.01800	.01800	.01800	.01800	.01800	.01800
45.5	.02690	.02400	.02240	.02090	.01870	.01860	.01850	.01840	.01830	.01830	.01830	.01830	.01830	.01830	.01830	.01830
46.	.02730	.02440	.02280	.02120	.01900	.01890	.01880	.01870	.01860	.01860	.01860	.01860	.01860	.01860	.01860	.01860
46.5	.02780	.02480	.02320	.02160	.01930	.01920	.01910	.01900	.01890	.01890	.01890	.01890	.01890	.01890	.01890	.01890
47.	.02820	.02520	.02350	.02190	.01960	.01950	.01940	.01930	.01920	.01920	.01920	.01920	.01920	.01920	.01920	.01920
47.5	.02870	.02560	.02390	.02230	.01990	.01980	.01970	.01960	.01950	.01950	.01950	.01950	.01950	.01950	.01950	.01950
48.	.02910	.02600	.02430	.02260	.02020	.02010	.02000	.01990	.01980	.01980	.01980	.01980	.01980	.01980	.01980	.01980
48.5	.02960	.02640	.02460	.02300	.02050	.02040	.02030	.02020	.02010	.02010	.02010	.02010	.02010	.02010	.02010	.02010
49.	.03000	.02680	.02500	.02330	.02080	.02070	.02060	.02050	.02040	.02040	.02040	.02040	.02040	.02040	.02040	.02040
49.5	.03050	.02730	.02540	.02370	.02120	.02110	.02100	.02090	.02080	.02070	.02070	.02070	.02070	.02070	.02070	.02070
50.0	.03090	.02770	.02580	.02400	.02150	.02140	.02130	.02120	.02110	.02100	.02100	.02100	.02100	.02100	.02100	.02100

TABLE III (Cont.)—OBSERVED SPECIFIC GRAVITY.

Observed Temp. C.	0.65000	0.70000	0.75000	0.80000	0.85000	0.86000	0.87000	0.88000	0.89000	0.90000	0.91000	0.9200	0.93000	0.94000	0.95000	0.96000
	ADD TO OBSERVED SPECIFIC GRAVITY TO GIVE TRUE SPECIFIC GRAVITY AT 60°/60° F. or 15.6° C.															
50.5	.03140	.02810	.02620	.02440	.02180	.02170	.02160	.02150	.02140	.02130	.02130	.02130	.02130	.02130	.02130	.02130
51.	.03180	.02850	.02650	.02470	.02210	.02200	.02190	.02180	.02170	.02160	.02160	.02160	.02160	.02160	.02160	.02160
51.5	.03230	.02890	.02690	.02510	.02240	.02230	.02220	.02210	.02200	.02190	.02190	.02190	.02190	.02190	.02190	.02190
52.	.03270	.02930	.02730	.02540	.02270	.02260	.02250	.02240	.02230	.02220	.02220	.02220	.02220	.02220	.02220	.02220
52.5	.03320	.02970	.02770	.02580	.02300	.02290	.02280	.02270	.02260	.02260	.02260	.02260	.02260	.02260	.02260	.02260
53.	.03360	.03010	.02800	.02610	.02340	.02330	.02320	.02310	.02300	.02290	.02290	.02290	.02290	.02290	.02290	.02290
53.5	.03410	.03050	.02840	.02650	.02370	.02360	.02350	.02340	.02330	.02320	.02320	.02320	.02320	.02320	.02320	.02320
54.	.03450	.03090	.02880	.02680	.02400	.02390	.02380	.02370	.02360	.02350	.02350	.02350	.02350	.02350	.02350	.02350
54.5	.03500	.03130	.02920	.02720	.02430	.02420	.02410	.02400	.02390	.02380	.02380	.02380	.02380	.02380	.02380	.02380
55.	.03540	.03170	.02950	.02750	.02460	.02450	.02440	.02430	.02420	.02410	.02410	.02410	.02410	.02410	.02410	.02410
55.5	.03590	.03210	.02990	.02790	.02490	.02480	.02470	.02460	.02450	.02440	.02440	.02440	.02440	.02440	.02440	.02440
56.	.03630	.03250	.03030	.02820	.02520	.02510	.02500	.02490	.02480	.02470	.02470	.02470	.02470	.02470	.02470	.02470
56.5	.03680	.03290	.03070	.02860	.02550	.02540	.02530	.02520	.02510	.02500	.02500	.02500	.02500	.02500	.02500	.02500
57.	.03720	.03330	.03100	.02890	.02580	.02570	.02560	.02550	.02540	.02530	.02530	.02530	.02530	.02530	.02530	.02530
57.5	.03770	.03370	.03140	.02930	.02610	.02600	.02590	.02580	.02570	.02560	.02560	.02560	.02560	.02560	.02560	.02560
58.	.03810	.03410	.03180	.02960	.02650	.02630	.02620	.02610	.02600	.02590	.02590	.02590	.02590	.02590	.02590	.02590
58.5	.03860	.03450	.03210	.03000	.02680	.02660	.02650	.02640	.02630	.02620	.02620	.02620	.02620	.02620	.02620	.02620
59.	.03900	.03490	.03250	.03030	.02710	.02690	.02680	.02670	.02660	.02650	.02650	.02650	.02650	.02650	.02650	.02650
59.5	.03950	.03530	.03290	.03070	.02740	.02720	.02710	.02700	.02690	.02680	.02680	.02680	.02680	.02680	.02680	.02680
60.	.04000	.03570	.03330	.03100	.02780	.02760	.02740	.02730	.02720	.02710	.02710	.02710	.02710	.02710	.02710	.02710
60.5	.04040	.03610	.03360	.03140	.02800	.02790	.02780	.02760	.02750	.02740	.02740	.02740	.02740	.02740	.02740	.02740
61.	.04080	.03650	.03400	.03170	.02830	.02810	.02790	.02770	.02760	.02770	.02770	.02770	.02770	.02770	.02770	.02770
61.5	.04130	.03690	.03440	.03210	.02860	.02840	.02820	.02810	.02800	.02810	.02810	.02810	.02810	.02810	.02810	.02810
62.	.04170	.03730	.03480	.03240	.02900	.02880	.02870	.02860	.02850	.02840	.02840	.02840	.02840	.02840	.02840	.02840
62.5	.04220	.03770	.03520	.03280	.02930	.02910	.02900	.02890	.02880	.02870	.02870	.02870	.02870	.02870	.02870	.02870
63.	.04260	.03810	.03550	.03310	.02960	.02940	.02930	.02920	.02910	.02900	.02900	.02900	.02900	.02900	.02900	.02900
63.5	.04310	.03850	.03590	.03340	.02990	.02970	.02960	.02950	.02940	.02930	.02930	.02930	.02930	.02930	.02930	.02930
64.	.04350	.03890	.03630	.03380	.03020	.03000	.02990	.02980	.02970	.02960	.02960	.02960	.02960	.02960	.02960	.02960
64.5	.04400	.03936	.03660	.03420	.03050	.03030	.03020	.03010	.03000	.02990	.02990	.02990	.02990	.02990	.02990	.02990
65.	.04440	.03970	.03700	.03450	.03080	.03070	.03050	.03040	.03030	.03020	.03020	.03020	.03020	.03020	.03020	.03020
65.5	.04490	.04010	.03740	.03490	.03110	.03090	.03080	.03070	.03060	.03050	.03050	.03050	.03050	.03050	.03050	.03050
66.	.04530	.04050	.03780	.03520	.03150	.03130	.03110	.03100	.03090	.03080	.03080	.03080	.03080	.03080	.03080	.03080
66.5	.04580	.04090	.03820	.03560	.03180	.03160	.03140	.03130	.03120	.03110	.03110	.03110	.03110	.03110	.03110	.03110
67.	.04620	.04130	.03850	.03590	.03210	.03190	.03170	.03160	.03150	.03140	.03140	.03140	.03140	.03140	.03140	.03140
67.5	.04670	.04170	.03890	.03630	.03240	.03220	.03200	.03190	.03180	.03170	.03170	.03170	.03170	.03170	.03170	.03170
68.	.04710	.04210	.03930	.03660	.03270	.03250	.03230	.03220	.03210	.03200	.03200	.03200	.03200	.03200	.03200	.03200
68.5	.04750	.04250	.03960	.03700	.03300	.03280	.03260	.03250	.03240	.03230	.03230	.03230	.03230	.03230	.03230	.03230
69.	.04800	.04300	.04000	.03730	.03330	.03310	.03290	.03280	.03270	.03260	.03260	.03260	.03260	.03260	.03260	.03260
69.5	.04850	.04340	.04040	.03770	.03370	.03350	.03330	.03320	.03310	.03300	.03300	.03300	.03300	.03300	.03300	.03300
70.	.04900	.04380	.04080	.03800	.03400	.03380	.03360	.03350	.03340	.03330	.03330	.03330	.03330	.03330	.03330	.03330
70.5	.04940	.04420	.04110	.03840	.03430	.03410	.03390	.03380	.03370	.03360	.03360	.03360	.03360	.03360	.03360	.03360
71.	.04980	.04460	.04150	.03870	.03460	.03440	.03420	.03410	.03400	.03390	.03390	.03390	.03390	.03390	.03390	.03390
71.5	.05030	.04500	.04190	.03910	.03500	.03480	.03460	.03440	.03430	.03420	.03420	.03420	.03420	.03420	.03420	.03420
72.	.05070	.04540	.04230	.03940	.03520	.03500	.03480	.03470	.03460	.03450	.03450	.03450	.03450	.03450	.03450	.03450
72.5	.05120	.04580	.04260	.03980	.03540	.03520	.03510	.03500	.03490	.03480	.03480	.03480	.03480	.03480	.03480	.03480
73.	.05160	.04620	.04300	.04010	.03580	.03560	.03540	.03530	.03520	.03510	.03510	.03510	.03510	.03510	.03510	.03510
73.5	.05210	.04660	.04340	.04050	.03610	.03590	.03570	.03560	.03550	.03540	.03540	.03540	.03540	.03540	.03540	.03540
74.	.05250	.04700	.04380	.04080	.03650	.03630	.03610	.03590	.03580	.03570	.03570	.03570	.03570	.03570	.03570	.03570
74.5	.05300	.04740	.04410	.04120	.03680	.03660	.03640	.03620	.03610	.03600	.03600	.03600	.03600	.03600	.03600	.03600
75.	.05340	.04780	.04450	.04150	.03710	.03690	.03670	.03650	.03640	.03630	.03630	.03630	.03630	.03630	.03530	.03630
75.5	.05390	.04820	.04490	.04190	.03740	.03720	.03700	.03680	.03670	.03660	.03660	.03660	.03660	.03660	.03660	.03660
76.	.05430	.04860	.04530	.04220	.03770	.03750	.03730	.03710	.03700	.03690	.03690	.03690	.03690	.03690	.03690	.03690
76.5	.05480	.04900	.04560	.04260	.03800	.03780	.03760	.03740	.03730	.03720	.03720	.02720	.03720	.03720	.03720	.03720
77.	.05520	.04940	.04600	.04290	.03830	.03810	.03790	.03770	.03760	.03750	.03750	.03750	.03750	.03750	.03750	.03750
77.5	.05570	.04980	.04640	.04330	.03870	.03850	.03830	.03810	.03800	.03790	.03790	.03790	.03790	.03790	.03790	.03790
78.	.05610	.05020	.04680	.04360	.03900	.03880	.03860	.03840	.03830	.03820	.03820	.03820	.03820	.03820	.03820	.03820
78.5	.05660	.05060	.04710	.04400	.03930	.03910	.03890	.03870	.03860	.03850	.03850	.03850	.03850	.03850	.03850	.03850
79.	.05700	.05100	.04750	.04430	.03960	.03940	.03920	.03900	.03890	.03880	.03880	.03880	.03880	.03880	.03880	.03880
79.5	.05750	.05140	.04790	.04470	.03990	.03970	.03950	.03930	.03920	.03910	.03910	.03910	.03910	.03910	.03910	.03910
80.	.05790	.05180	.04830	.04500	.04020	.04000	.03980	.03960	.03950	.03940	.03940	.03940	.03940	.03940	.03940	.03940
80.5	.05840	.05220	.04860	.04540	.04050	.04030	.04010	.03990	.03980	.03970	.03970	.03970	.03970	.03970	.03970	.03970
81.	.05880	.05260	.04900	.04570	.04080	.04060	.04040	.04020	.04010	.04000	.04000	.04000	.04000	.04000	.04000	.04000
81.5	.05930	.05300	.04940	.04610	.04120	.04100	.04080	.04060	.04040	.04030	.04030	.04030	.04030	.04030	.04030	.04030
82.	.05970	.05340	.04980	.04640	.04150	.04130	.04110	.04090	.04070	.04060	.04060	.04060	.04060	.04060	.04060	.04060
82.5	.06020	.05380	.05010	.04680	.04180	.04160	.04140	.04120	.04100	.04090	.04090	.04090	.04090	.04090	.04090	.04090
83.	.06060	.05420	.05050	.04710	.04210	.04190	.04170	.04150	.04130	.04120	.04120	.04120	.04120	.04120	.04120	.04120
83.5	.06110	.05460	.05090	.04750	.04240	.04220	.04200	.04180	.04160	.04150	.04150	.04150	.04150	.04150	.04150	.04150
84.	.06150	.05500	.05130	.04780	.04270	.04250	.04230	.04200	.04190	.04180	.04180	.04180	.04180	.04180	.04180	.04180
84.5	.06200	.05540	.05160	.04820	.04300	.04280	.04260	.04240	.04220	.04210	.04210	.04210	.04210	.04210	.04210	.04210
85.	.06240	.05580	.05200	.04850	.04330	.04310	.04290	.04270	.04250	.04240	.04240	.04240	.04240	.04240	.04240	.04240
85.5	.06290	.05620	.05240	.04890	.04370	.04350	.04330	.04310	.04290	.04280	.04280	.04280	.04280	.04280	.04280	.04280
86.	.06330	.05660	.05280	.04920	.04400	.04380	.04360	.04340	.04320	.04310	.04310	.04310	.04310	.04310	.04310	.04310
86.5	.06380	.05700	.05310	.04960	.04430	.04410	.04390	.04370	.04350	.04340	.04340	.04340	.04340	.04340	.04340	.04340
87.	.06420	.05740	.05350	.04990	.04460	.04440	.04420	.04400	.04380	.04370	.04370	.04370	.04370	.04370	.04370	.04370
87.5	.06470	.05780	.05390	.05030	.04490	.04470	.04450	.04430	.04410	.04400	.04400	.04400	.04400	.04400	.04400	.04400
88.	.06510	.05820	.05430	.05060	.04520	.04500	.04480	.04460	.04440	.04430	.04430	.04430	.04430	.04430	.04430	.04430
88.5	.06560	.05860	.05460	.05100	.04550	.04530	.04510	.04500	.04470	.04460	.04460	.04460	.04460	.04460	.04460	.04460
89.	.06600	.05900	.05500	.05130	.04580	.04560	.04540	.04520	.04500	.04490	.04490	.04490	.04490	.04490	.04490	.04490
89.5	.06650	.05940	.05540	.05170	.04620	.04600	.04580	.04560	.04540	.04520	.04520	.04520	.04520	.04520	.04520	.04520
90.	.06690	.05990	.05580	.05200	.04650	.04630	.04610	.04590	.04570	.04550	.04550	.04550	.04550	.04550	.04550	.04550
90.5	.06740	.06030	.05610	.05240	.04680	.04660	.04640	.04620	.04600	.04580	.04580	.04580	.04580	.04580	.04580	.04580
91.	.06780	.06070	.05650	.05270	.04710	.04690	.04670	.04650	.04630	.04610	.04610	.04610	.04610	.04610	.04610	.04610
91.5	.06830	.06110	.05690	.05310	.04740	.04720	.04700	.04680	.04660	.04640	.04640	.04640	.04640	.04640	.04640	.04640
92.	.06870	.06150	.05730	.05340	.04770	.04750	.04730	.04710	.04690	.04670	.04670	.04670	.04670	.04670	.04670	.04670
92.5	.06920	.06190	.05760	.05380	.04800	.04780	.04760	.04740	.04720	.04700	.04700	.04700	.04700	.04700	.04700	.04700
93.	.06960	.06230	.05800	.05410	.04830	.04810	.04790	.04770	.04750	.04730	.04730	.04730	.04730	.04730	.04730	.04730
93.5	.07010	.06270	.05840	.05450	.04870	.04850	.04820	.04800	.04780	.04760	.04760	.04760	.04760	.04760	.04760	.04760
94.	.07050	.06310	.05880	.05480	.04900	.04870	.04850	.04830	.04810	.04790	.04790	.04790	.04790	.04790	.04790	.04790
94.5	.07100	.06340	.05910	.05520	.04930	.04910	.04890	.04870	.04850	.04830	.04830	.04830	.04830	.04830	.04830	.04830
95.	.07140	.06390	.05950	.05550	.04960	.04940	.04920	.04900	.04880	.04860	.04860	.04860	.04860	.04860	.04860	.04860
95.5	.07190	.06430	.05990	.05590	.04990	.04970	.04950	.04930	.04910	.04890	.04890	.04890	.04890	.04890	.04890	.04890
96.	.07230	.06470	.06030	.05620	.05020	.05000	.04980	.04960	.04940	.04920	.04920	.04920	.04920	.04920	.04920	.04920
96.5	.07280	.06510	.06060	.05660	.05050	.05030	.05010	.04990	.04970	.04950	.04950	.04950	.04950	.04950	.04950	.04950
97.	.07320	.06550	.06100	.05690	.05080	.05060	.05040	.05020	.05000	.04980	.04980	.04980	.04980	.04980	.04980	.04980
97.5	.07370	.06590	.06140	.05730	.05110	.05090	.05070	.05050	.05030	.05010	.05010	.05010	.05010	.05010	.05010	.05010
98.	.07410	.06630	.06180	.05760	.05150	.05120	.05100	.05080	.05060	.05040	.05040	.05040	.05040	.05040	.05040	.05040
98.5	.07460	.06670	.06210	.05800	.05180	.05150	.05130	.05110	.05090	.05070	.05070	.05070	.05070	.05070	.05070	.05070
99.	.07500	.06710	.06250	.05830	.05210	.05180	.05160	.05140	.05120	.05100	.05100	.05100	.05100	.05100	.05100	.05100
99.5	.07550	.06750	.06290	.05870	.05240	.05210	.05190	.05170	.05150	.05130	.05130	.05130	.05130	.05130	.05130	.05130
100.	.07590	.06790	.06330	.05900	.05270	.05240	.05220	.05200	.05180	.05160	.05160	.05160	.05160	.05160	.05160	.05160

TABLE IV.—FUEL OIL CHART.

Degrees Baume	Specific Gravity	Lbs. Per U. S. Gallon	Cu. Ft. Per Long Ton	Degrees Baume	Specific Gravity	Lbs. Per U. S. Gallon	Cu. Ft. Per Long Ton
10.0	1.0000	8.3280	35.956		.9370	7.8033	38.373
	.9990	8.3190	35.992	19.5	.9365	7.7990	38.390
	.9980	8.3110	36.028		.9360	7.7950	38.414
	.9970	8.3030	36.064		.9350	7.7860	38.455
10.5	.9964	8.2990	36.080		.9340	7.7780	38.496
	.9960	8.2940	36.100	20.0	.9333	7.7720	38.520
	.9950	8.2860	36.140		.9330	7.7700	38.538
	.9940	8.2780	36.174		.9320	7.7610	38.579
11.0	.9930	8.2690	36.210		.9310	7.7530	38.621
	.9920	8.2610	36.250	20.5	.9300	7.7450	38.662
	.9910	8.2530	36.282		.9290	7.7367	38.704
	.9900	8.2447	36.319		.9280	7.7283	38.745
11.5	.9894	8.2400	36.330	21.0	.9270	7.7200	38.787
	.9890	8.2360	36.356		.9260	7.7110	38.829
	.9880	8.2280	36.392		.9250	7.7034	38.871
	.9870	8.2200	36.429	21.5	.9240	7.6950	38.913
12.0	.9860	8.2110	36.466		.9230	7.6860	38.955
	.9850	8.2030	36.503		.9220	7.6780	38.998
	.9840	8.1940	36.540	22.0	.9210	7.6700	39.040
	.9830	8.1860	36.578		.9200	7.6617	39.082
12.5	.9825	8.1820	36.590		.9190	7.6530	39.125
	.9820	8.1780	36.615	22.5	.9180	7.6450	39.167
	.9810	8.1690	36.652		.9170	7.6360	39.210
	.9800	8.1614	36.689		.9160	7.6280	39.253
13.0	.9790	8.1530	36.727	23.0	.9150	7.6200	39.296
	.9780	8.1440	36.765		.9140	7.6110	39.339
	.9770	8.1340	36.802		.9130	7.6030	39.382
	.5760	8.1280	36.840	23.5	.9120	7.5950	39.425
13.5	.9756	8.1250	36.860		.9110	7.5860	39.468
	.9750	8.1190	36.878		.9100	7.5784	39.512
	.9740	8.1110	36.915	24.0	.9090	7.5700	39.555
	.9730	8.1030	36.953		.9080	7.5610	39.599
14.0	.9720	8.0940	36.991		.9070	7.5530	39.642
	.9710	8.0860	37.030	24.5	.9060	7.5450	39.686
	.9700	8.0781	37.068		.9050	7.5360	39.730
	.9690	8.0698	37.106		.9040	7.5280	39.774
14.5	.9688	8.0690	37.110	25.0	.9030	7.5200	39.818
	.9680	8.0610	37.144		.9020	7.5110	39.862
	.9670	8.0530	37.183		.9010	7.5030	39.906
	.9660	8.0440	37.221	25.5	.9000	7.4952	39.951
15.0	.9655	8.0410	37.240		.8990	7.4860	39.996
	.9650	8.0360	37.260		.8980	7.4780	40.040
	.9640	8.0280	37.298	26.0	.8974	7.4730	40.060
	.9630	8.0190	37.337		.8970	7.4700	40.083
15.5	.9620	8.0110	37.376		.8960	7.4610	40.129
	.9610	8.0030	37.415		.8950	7.4530	40.174
	.9600	7.9948	37.454	26.5	.8946	7.4490	40.190
	.9590	7.9865	37.493		.8940	7.4450	40.219
16.0	.9589	7.9860	37.500		.8930	7.4360	40.264
	.9580	7.9780	37.532		.8920	7.4280	40.309
	.9570	7.9690	37.571	27.0	.8917	7.4250	40.330
	.9560	7.9610	37.611		.8910	7.4200	40.354
16.5	.9556	7.9590	37.630		.8900	7.4119	40.400
	.9550	7.9530	37.650		.8890	7.4030	40.445
	.9540	7.9449	37.689	27.5	.8889	7.4020	40.450
	.9530	7.9360	37.729		.8880	7.3950	40.491
17.0	.9524	7.9310	37.740		.8870	7.3860	40.536
	.9520	7.9280	37.769	28.0	.8860	7.3780	40.582
	.9510	7.9190	37.808		.8850	7.3700	40.628
	.9500	7.9116	37.848		.8840	7.3610	40.674
17.5	.9492	7.9040	37.870	28.5	.8830	7.3530	40.720
	.9490	7.9032	37.888		.8820	7.3450	40.766
	.9480	7.8940	37.928		.8810	7.3360	40.814
	.9470	7.8860	37.968	29.0	.8800	7.3286	40.859
	.9460	7.8780	38.008		.8790	7.3200	40.905
18.0	.9459	7.8770	38.010		.8780	7.3110	40.952
	.9450	7.8690	38.048	29.5	.8777	7.3090	40.970
	.9440	7.8610	38.089		.8770	7.3030	40.999
	.9430	7.8530	38.129		.8760	7.2950	41.045
18.5	.9428	7.8510	38.140	30.0	.8750	7.2870	41.092
	.9420	7.8444	38.170		.8740	7.2786	41.139
	.9410	7.8360	38.210		.8730	7.2700	41.186
	.9400	7.8283	38.251	30.5	.8723	7.2640	41.220
19.0	.9396	7.8256	38.270		.8720	7.2620	41.234
	.9390	7.8190	38.291		.8710	7.2530	41.280
	.9380	7.8110	38.332		.8700	7.2450	41.328

rected specific gravity, the tons and parts of a ton can be found by Table IV, which gives the number of cubic feet contained in a ton of oil for the different specific gravities. Dividing the corrected volume by the cubic feet shown opposite the corrected specific gravity will give the tons of oil.

Examples

Case No. 1.—7,520 barrels, 18 Baume, 72 degrees Fahrenheit.

From Table I we find opposite 72 degrees F. the multiplier 0.995223. Multiplying 7,520 by 0.995223 gives 7484.07 as the correct amount at the standard temperature.

Case No. 2.—7,520 barrels, 18 Baume, 20 degrees Centigrade.

From Table II we find opposite 20 degrees C. the multiplier 0.99681. Multiplying 7,520 by 0.99681 gives 7,496.01 as the correct amount at the standard temperature.

Case No. 3.—15,500 cubic feet, 0.94 specific gravity, 24 degrees Centigrade.

From Table II opposite 24 degrees Centigrade we find the multiplier 0.9939588. Multiplying 15,500 by this gives 15,406.36 as the correct amount at the standard temperature. From Table III under 0.94 specific gravity and opposite 24 degrees Centigrade we find the constant 0.0051, which must be added to the specific gravity of 0.94, giving 0.9451 as the corrected specific gravity at the standard temperature. From Table IV opposite 0.9450 we find 38.048 cubic feet to a ton, and by interpolation we find that 0.9451 would be 38.043 cubic feet to the ton. Dividing the corrected volume 15,406.36 by 38.043 gives 404.9722 tons as the correct amount, and this reduced to the English measure gives 404 tons 19 hundredweight 1 quarter 18 pounds.

These calculations might seem tedious and unnecessary, but with the high price of fuel and the great difference caused by expansion it is absolutely necessary to make them so that a correct check can be had on the amount bought.

The tables referred to above have been made up from data published by the United States Government and are reasonably correct.

Examples Showing How to Apply Temperature Correction Table

Explanation.—Referring to the temperature correction table, 15.6 degrees Centigrade equals the normal temperature of fuel oil. The figure opposite 15.6 degrees Centigrade is 1.0000, which is the multiplier at this particular temperature.

Fuel oil at a temperature below 15.6 degrees Centigrade shows a contraction in its volume with a corresponding increase in its multiplier as shown in the table.

Fuel oil at temperatures above 15.6 degrees Centigrade shows an expansion in its volume with a corresponding decrease in its multiplier as shown in table.

Rule.—Multiply barrels or cubic feet of fuel oil under consideration by multiplier in column opposite temperature of oil under consideration.

Example.—Temperature below 15.6 degrees Centigrade. Referring to chart, 10 degrees Centigrade = 1.00402 multiplier; 500 barrels or cubic feet of fuel oil at 10 degrees Centigrade. Then, 500 × 1.00402 = 502.01 barrels or cubic feet, net amount fuel oil.

Example.—Temperature above 15.6 degrees Centigrade; 500 barrels or cubic feet at 25 degrees Centigrade. Referring to chart, 25 degrees Centigrade = .993246. Then, 500 × .993246 = 496.623 barrels or cubic feet fuel oil = net amount.

Standardization of Petroleum Specifications

ORGANIZATION of the Interdepartmental Committee on Standardization of Petroleum Specifications, which supersedes the war-time committee on the same subject, was effected at the first meeting of the Committee held at the Bureau of Mines, Washington, D. C., February 19. In addition, the Committee gave its approval to Bulletin 5 of the old Committee, thus continuing in force the specifications on gasoline, kerosene, fuel oils, lubricating oils, signal oils, etc., contained in that bulletin. The Committee further decided to adopt the plan of adding a technical sub-committee to handle the details of drawing up and revising specifications and methods of testing. Dr. H. Foster Bain, acting director of the Bureau of Mines, appointed N. A. C. Smith, petroleum chemist, to represent him as chairman of the technical committee.

Mold Loft Suggestions—II

Development of Longitudinals in Isherwood Construction—Miscellaneous Problems

BY J. I. HESS*

THE method of developing the shell described in the last issue is admirably adapted to determining the shape of the longitudinals in the Isherwood type of construction. But it is necessary to locate the inboard heel of the longitudinal on the body plan before beginning the work of development. The method of locating this line is simple, but before taking that up it will be of interest to describe, briefly, the bevel board and its application to this particular problem.

The Bevel Board

The bevel board consists of numerous radii dividing an arc into degrees, as shown in Fig. 8. Draw a straight horizontal line. At any point O on this line, and with any convenient radius, say 24 inches, draw an arc of 90 degrees. If this arc be divided into 90 equal parts, each segment will subtend an angle of one degree at the center O. From O draw lines of indefinite length through these division points and we have the basis of the bevel board. The first 45 degrees or 50 degrees up from the horizontal base line are all that will be needed.

We will assume that the frame spacing is 24 inches. From O measure out 24 inches on the horizontal line to B and erect a perpendicular. Use a hardwood stick about 30 inches long and 1 inch wide and 3/16 inch thick, with beveled edges, if desired. Lay it along the perpendicular just erected, with the end flush with the base at B, and pick up each intersection, numbering them from O at the end of the stick up to 45, or more if needed. These points should be squared across the stick so that both edges will be the same. When this is done, mark the stick in some conspicuous place with the frame space for which it was made (24 inches in this case) and make a similar stick for each different spacing.

To find the bevel of a frame at any point, place the stick at right angles to the molded line, with the end at the point in question, and read the required bevel at the point of intersection with the next frame. For most conditions a bevel stick made on a base of one frame space gives results close enough, but in the extreme after body, or where the bevel is changing rapidly from frame to frame, it is necessary to use two frame spaces as the base. In this case the stick is applied across two frame spaces on the body plan and the bevel thus obtained is for the frame in between. The reason for this is seen in Fig. 9. The angle BAC will be the bevel of the frame at D, since the line AC is approximately parallel to the tangent to the curve at the point D.

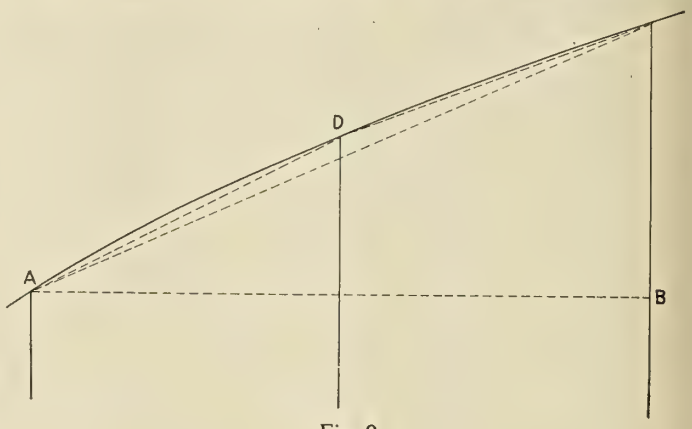


Fig. 9

In the body plan of an Isherwood boat it is necessary to use auxiliary frame lines, spaced not more than 30 inches, for the purpose of "fairing up." In Fig. 10 let AC and BD be any two such adjacent frames and the figure, as shown, a portion of a longitudinal. Draw AF perpendicular to DB and AE perpendicular to CD. For all practical purposes $ABDC$ may be considered a parallelogram, from which assumption it is easily seen that angle EAC = angle BAF, or the angle of bevel. (Similar triangle.) From this it will be seen that AC, the distance between heels of the longitudinal in the plane of the frame, will be the width of the member EA divided by the cosine of the angle of bevel EAC, or

$$AC = \frac{EA}{\text{Cos } \phi}.$$

As a matter of convenience, we should pick up these varying values of AC on a stick to be used in connection with the bevel stick in spotting the points D, C, etc., on the floor. To illustrate the method of procedure, let us assume that we are working on a 12-inch channel. In Fig. 8 measure

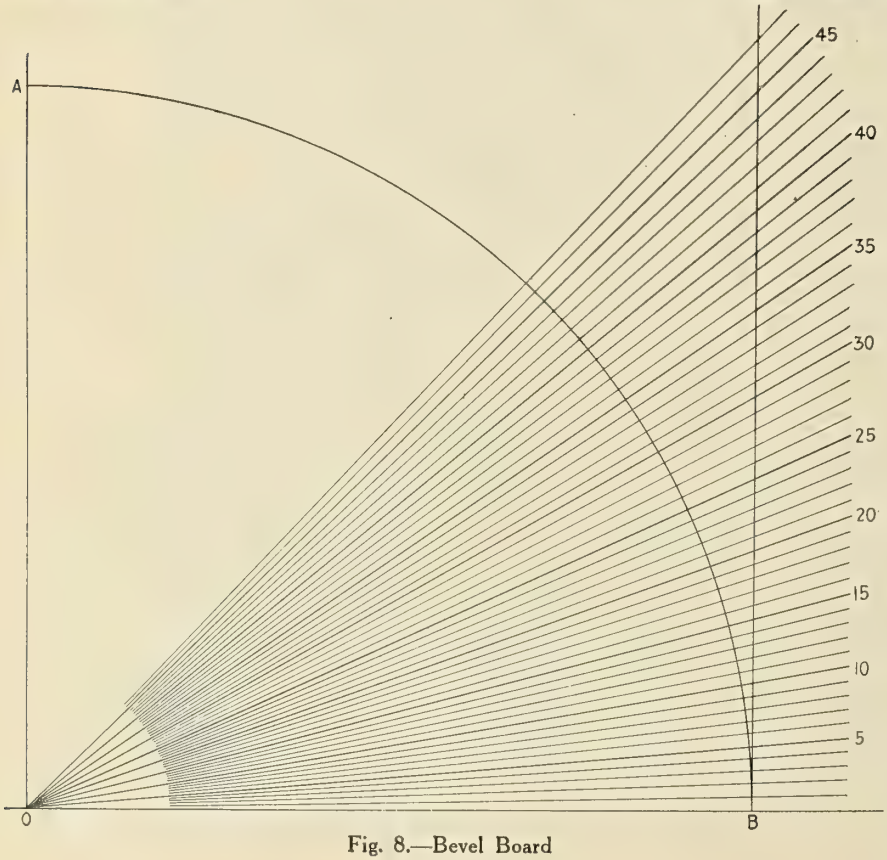


Fig. 8.—Bevel Board

* Formerly mold loft foreman, Ames Shipbuilding and Drydock Company, Seattle, Wash.

out 12 inches from O to B and erect a perpendicular. Use a stick like the bevel stick, and with any pitch mark near its end held on O pick up the length of the hypothenuse for each variation in the angle at O. (It is better to use a pitch mark rather than the end of the stick, owing to its greater accuracy.) These points will be marked with the degree of angle to correspond with the marking on the bevel stick.

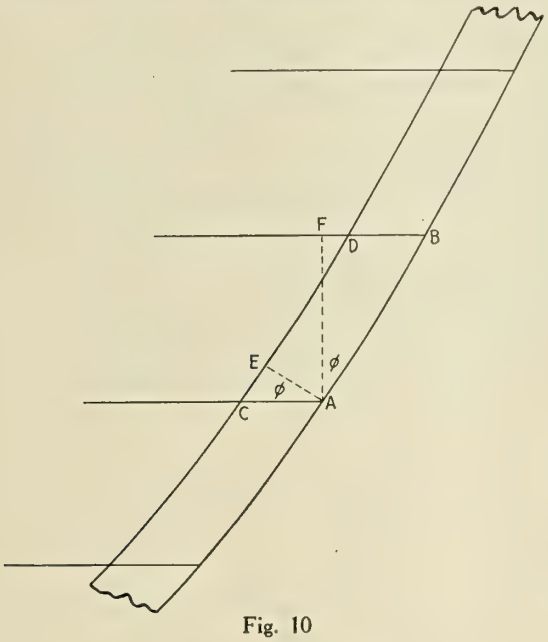


Fig. 10

Similar scales should be prepared for each width of longitudinal used, and considerable care should be taken to insure accuracy. For convenience we shall call these longitudinal sticks."

In Fig. 11 let $A'B'$ be the molded heel of the longitudinal under consideration. From each intersection made by this line with the molded frames square a line inboard from the frame as shown. These will correspond to the lines DB, CA, etc., in Fig. 10 and will lie in the plane of the frames. Now apply the proper bevel stick between the frames A' and B'—not along the line $A'B'$, but at right angles to the frame at A'

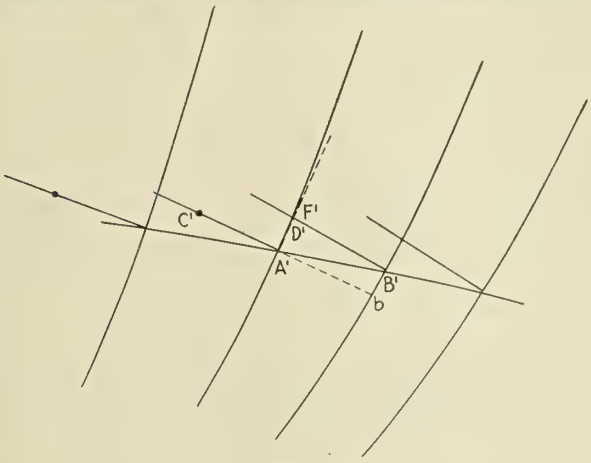


Fig. 11

or along the line $C'A'$ produced. Let us suppose it reads 30 degrees. With the pitch mark at A' apply the longitudinal stick just described along the line $C'A'$, and at 30 spot the point C'. In a like manner the inboard heel is located at each frame. When that is done the development proceeds as described for the shell.

Right here we must watch for an error. In Fig. 10 angle FAB will be the angle of bevel only when AB coincides with Ab, Fig. 11. This seldom, if ever, happens, but where the adjacent frames are approximately parallel near the longitudinal the difference in the two angles will rarely be enough to consider. However, we must know that such a condition exists and make proper allowance for it when necessary.

At A' erect a perpendicular to $C'A'$. It will intersect $B'D'$ at F'. Then angle $F'A'B'$ in Fig. 11 must be the projection of an angle whose true size is FAB in Fig. 10. The difference between that angle (ϕ) and the bevel of the frame at A will then be due to the difference between the lengths of $F'B'$ and $A'b$ on one side of the triangle and the expanded frame space FA and the true frame space on the other.

While this difference is usually negligible in all members that stand normal to the frame (because $F'B'$ is usually enough longer than $A'b$ to offset the increased length of the expanded frame space), it must be considered in all cases where the angle in question lies in a plane that approaches the horizontal or crosses the frame at an angle other than 90

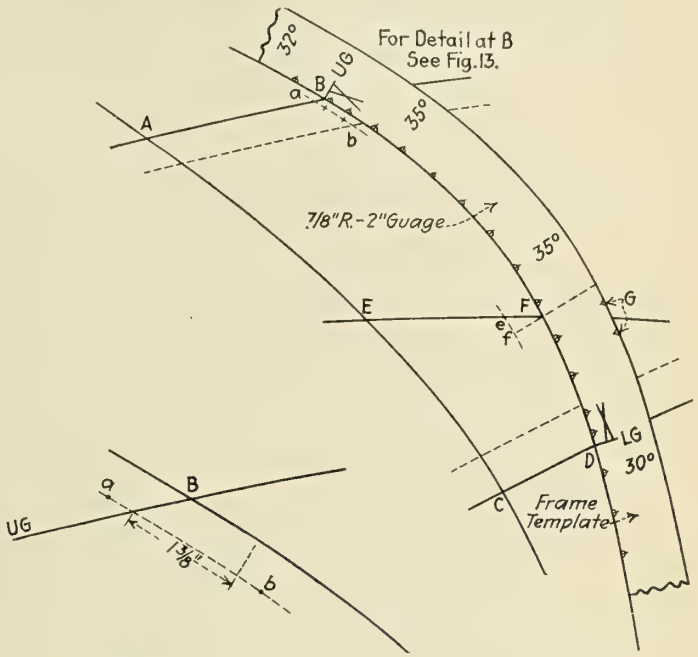


Fig. 12

Fig. 13

degrees. This will be illustrated later in a discussion of the deck stringer bar.

When the expansion is complete there will be two long, parallel lines of battens tacked to the floor. A positive check on the accuracy of the work will be found in measuring the distance between them. If it is a 12-inch channel, then EA should be exactly 12 inches at every point. If it fails in this, a recheck of the development work will probably disclose the error.

These longitudinal sticks are very essential in determining the depth of the cutout in the transverse to allow for the free passage of the longitudinal. A careless loftsman can easily make a poor "guess" in this and cause expensive delay in assembling on the ways. Owing to the angle at which the transverse and the longitudinal intersect (angle CAE, Fig. 10), a 12-inch channel may easily require more than 15 inches clearance from the shell to allow free passage. Simply locate the inboard heel on the template while on the floor by the method shown in Fig. 12 and add on the proper amount of clearance.

It is well to remember that, if the longitudinal is on an outside strake of plating, better results will be obtained if the development work is carried on from a line on the inside edge of the shell, or the actual location of the heel, rather than from the molded line; but, as in the shell expansion, this will not always be necessary. It will, however, be necessary in determining the depth of the cutout just referred to.

Few loftsmen take full advantage of the opportunities offered by a study of the bevel board's uses. Besides the longitudinal sticks already described, there are several other equally useful scales that can be made from it. Numerous problems in descriptive geometry are encountered by the man

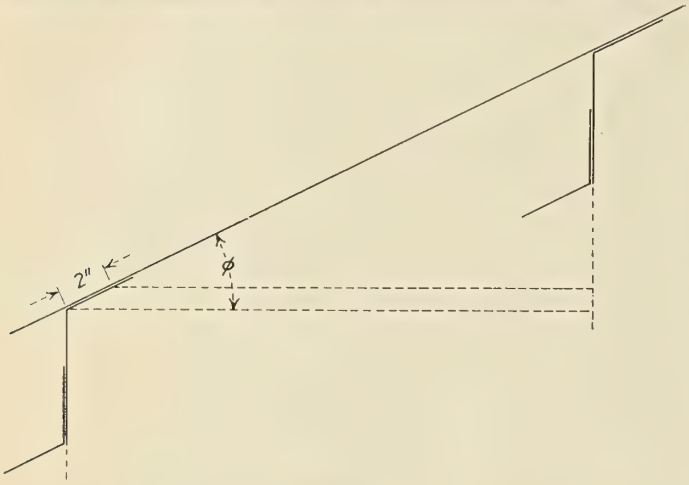


Fig. 14

who works on the lines and, while most of them are usually overlooked, they are important. An intelligent use of these scales helps to solve many of them.

Miscellaneous

One such problem occurs where the edge of a shell plate crosses the molded frame at a sharp angle, when the frame has considerable bevel, as often happens in the after peak.

In Fig. 12 let *AB* and *CD* be the upper and lower edges, respectively, of a shell plate in the after body. A common form of frame template is shown with the holes in the shell flange marked on the heel. If the shell flange is 3½ inches wide, the rivet gage will be 2 inches from the heel. Where there is bevel in the frame, as at *B*, the projection of this 2-inch gage line will lie some place between the two frames. A glance at Fig. 14 shows that the distance from *B* to this projection will be $2 \times \sin \phi$, where ϕ is the angle of bevel.

If we turn to Fig. 8 and draw an arc with a radius of 2 inches about *O* as a center we get this distance for any degree of bevel by dropping perpendiculars from the points of intersection of the arc and the radii to the base *AB*. It will be found very convenient to have these distances, together with the scales described later, picked up on a small stick to be carried in the pocket like a rule.

Choose a piece of hard, light-colored wood (lignum vitae is good) 6 inches long and 1¼ inches wide with beveled edges and diamond-shaped cross-section. With the end of the stick on the base line *OB*, Fig. 8, pick up these various heights and number the points to correspond with the degree of angle, as was done with the bevel stick (see Fig. 15, scale "*A*").

Suppose we apply the bevel stick to the frame at *B*, Fig. 13, and find 35 degrees. Place the end of the scale just made at right angles to the frame at *B* and at 35 spot a point. Through this point draw a short line across the sight edge of the plate and parallel to the molded frame, as at *ab*. The seam holes can then be spaced in on this line, with the proper landing from the edge of the plate, and squared back to the heel for record on the template. It is customary in some lofts to measure this landing directly on the heel of the frame. It will be seen from Fig. 13 that holes so located will not be in a fair line with the rest of the seam holes, and unless they are drawn back into line they will be too near the edge when the plate is sheared. If they are so drawn in they will not fit the frame and the frame holes will later have to be welded.

This correction is necessary only when the shell at that point is to be molded after the frame is made, which is usually the case. If the shell is done first and a record of the holes transferred from it to the frame, this error will not occur.

In Fig. 15 scales "*B*" and "*C*" are made in the same manner as scale "*A*" and used similarly. With *O* as a center and with a radius of 4½ inches, strike an arc as before and pick up the vertical distances from the intersections to the base *OB*. This gives us scale "*B*."

In a 6-inch by 6-inch bar the rivets near the toe will be spaced on a gage line that is 4½ inches from the heel. By the use of scale "*B*," as described for "*A*," any point in this line can be located on the body plan. At first thought there seems to be little need of this, but the worker will find numerous places where it is of advantage.

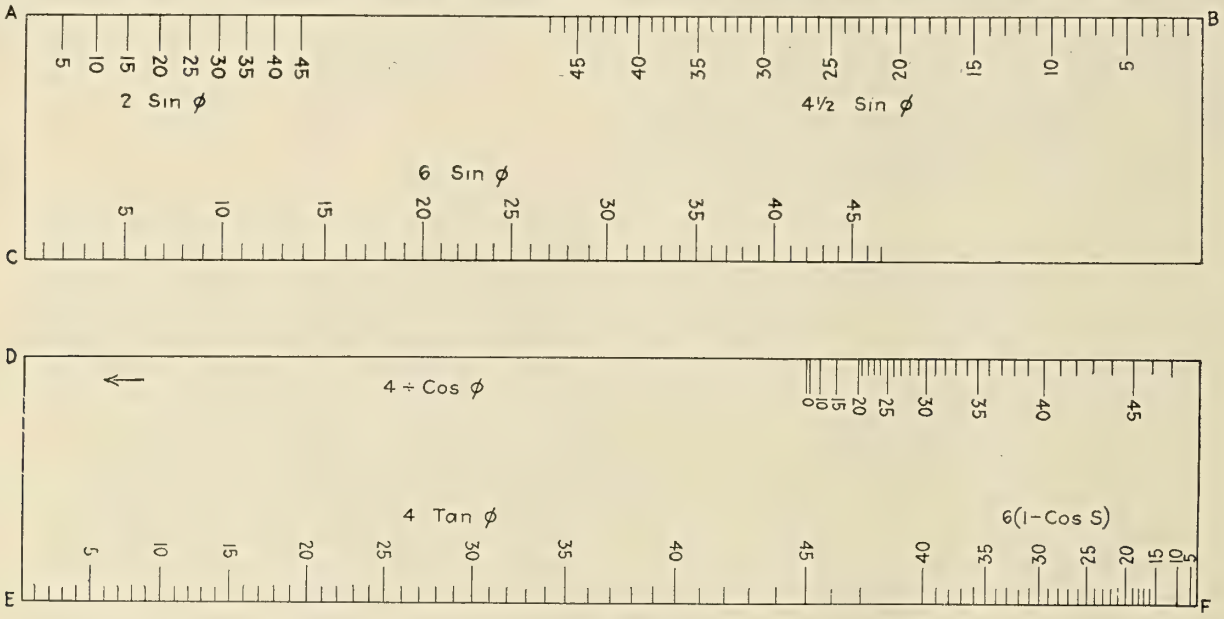


Fig. 15

Scale "*C*" will do nothing that cannot be done with "*B*," but there will be found occasions when it is more convenient to use. It is made on a base of 6 inches instead of 4½, and with its aid one can locate the toe of a 6-inch shell bar and get the angle of cut in way of the shell longitudinals. The panting stringers in a transverse framed boat also offer a good illustration of its use.

If the stringer bar is a 3½-inch by 7-inch angle the two holes in the 7-inch flange at each frame may be located on the heel of the template of the 3½-inch flange and thus save the time and labor of making an extra template. When there is much vertical "set" in the bar it will be necessary to make a smith mold of the wider flange, but a laying-out template will not be needed.

In Fig. 12 let *EF* be the molded heel of the stringer shell-clip. With the bevel stick we find a 33-degree bevel in the frame at *F*. Place scale "*C*" at right angles to the frame with the end at *F*, and at 33 thereon spot a point on the floor. Through this point draw the line *ef* parallel to the molded frame. We know, then, that this is the projection of a line that is 6 inches from the heel of the frame and lying in the plane of the shell flange. We also know that since *ef* is parallel to the frame it must be parallel to the plane of projection. Hence *ef* is the true length of the line.

From the description of Fig 3 (page 132, February issue) we learn that a line drawn through *F* perpendicular to the molded frame at that point must be the projection of a line that is at right angles to the frame. There *Ff* must be 6

In Fig. 16 draw any horizontal line *EF* to represent the inches.

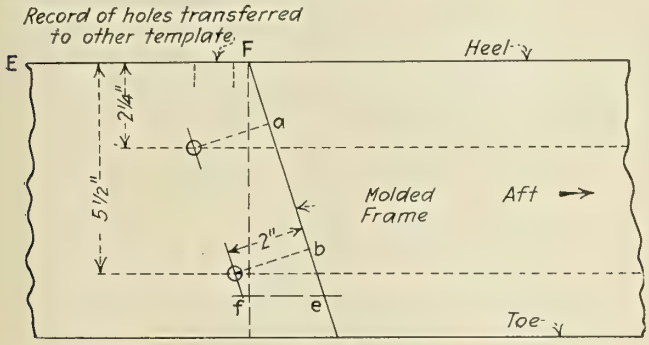


Fig. 16

heel of the stringer bar, and at *F* drop a perpendicular. If we measure down on this line 6 inches and over at right angles the distance *ef*, just found in Fig. 12, we strike a point in the heel of the frame. That is, the angle *EFD* in Fig. 12 is a projection of the angle whose true size is *EFf* in Fig. 16.

If the frame is a channel the holes will be located as shown in Fig. 16, unless there is too much bevel to allow easy riveting. In that case the bar will be held in place by a clip on the back of the channel, but in either method the solution is the same. When the holes are properly located, square up to the heel, and these points, in relation to *F*, will be the location of the holes when transferred to the template of the 3½-inch flange.

A similar problem occurs in the location of the holes at *G*, Fig. 12, in the inboard flange of the channel to take the bar. If we square in from *F* to the inboard edge of the template (made the width of the channel), we locate the top of the stringer plate. The error of measuring down from this point the thickness of the plate plus the gage of the rivets is very commonly made. A glance at Fig. 16 shows us that the proper measurements will be the distances *Fa* and *Fb* below the bottom edge of the stringer plate. Were this correction not made the bar would be too low and the molded shell and bulkhead clips would be worthless.

When clips are used to hold the bar to the channel, the precautions must be taken in locating the holes in the channel's web.

Bevels

The finding of the true bevel of a bar from its projection on the body plan many times offers a perplexing problem. The section of the angle shown on the floor lies in the plane of the frame and not at right angles to the heel. Hence, to find the true size of the angle it is necessary to pass a plane through the bar perpendicular to the heel and revolve it into the plane of projection.

The simplest illustration of this will be one in which one flange of the bar lies in a horizontal plane. Take, for instance, the bounding bar of the recess flat to the shell.

In Fig. 17 let *CA* and *EB* be two adjacent frames and *AB* the molded line of the recess flat, as shown on the body plan. Draw any line *CE* at any convenient distance from *AB* and parallel to it. Then *CE* must be parallel to the toe of the

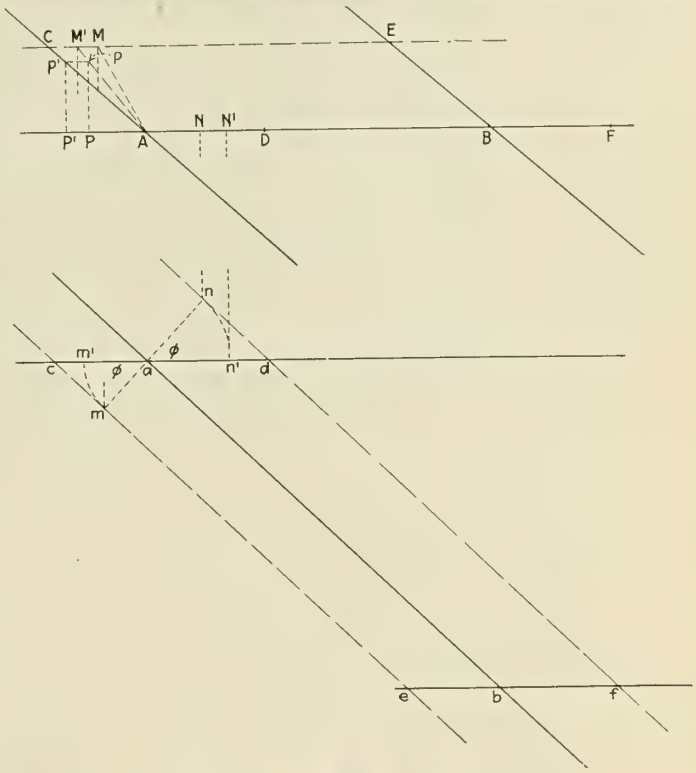


Fig. 17

standing flange. Since the deck flange of the bar lies in a horizontal plane, both the heel and the toe will coincide in the line *AB*.

In the horizontal projection *cd* and *ef* are the two adjacent frame lines. Then *C* falls at *c*, *A* at *a*, *B* at *b*, etc. If a plane *nam* be passed through *a* perpendicular to the heel, the intersection thus formed will show the true bevel of the bar and will be the angle sought.

Since the line *an* lies in the horizontal flange, the vertical projection of *n* will fall at *N* in the line *AB*. Likewise, the point *m* will lie in the line *CE* at *M*. Hence the angle *NAM* is the vertical projection of the angle under consideration.

If a vertical line be passed through the apex of this angle at *a* and used as an axis of rotation, *m* will move around to *m'* and *n* to *n'*. At the same time *N* travels to *N'* in the line *AB* and *M* to *M'* in the horizontal line *CE*. Therefore angle *N'AM'* is the angle required.

While this method gives perfect results, it is not always convenient to draw a horizontal projection. What the loftsman needs is a method of getting this angle directly from the body plan. An analysis of the small triangle *cma* shows that

$$\frac{ma}{ca} = \cos\phi, \text{ or } ca = \frac{ma}{\cos\phi}.$$

Since ϕ is known, we can assume any value for *ma* and find the corresponding value of *ca*. It will be noticed that this is the same formula used in getting the scales on the longitudinal sticks referred to earlier in this article. By assuming 4 inches as the base we have room on our 6-inch pocket piece for scale "*D*" (Fig. 15), which is obtained by picking up the lengths of the various hypothenuses made when a perpendicular is erected to the base *OB* at a point 4 inches distant from *O*.

When scale "*D*" is used, all we need to know to determine the bevel of the bar is the angle ϕ. If we apply the proper

bevel stick at right angles to the frame at A we get the angle made by the shell flange of the frame in a plane perpendicular to the frame's heel, or the bevel of the frame itself, but the angle we want *lies in the plane of the deck,* or on the beam line AB.

Hence apply the bevel stick along the line AB, with the end at A, and read the angle ϕ at B. Suppose it is 46 degrees. Lay scale "D" along the beam line extended and at 46 spot the point P'. The line PA will be 4 inches long. At P' erect a perpendicular to intersect the molded frame in the point p', and from p' draw a horizontal line to intersect the perpendicular from P in the point p. Then pAN is the required angle.

As the angle CAD approaches 90 degrees it will be found that the perpendicular from P' will not intersect the frame within reasonable limits. To avoid this divide both AP and AP' by the same number (some multiple of 4). The angle found will be the same in each case, if the ratio of AP to AP' is not changed.

When both flanges of the bar are inclined to the horizontal the solution remains the same, so long as the heel of the bar itself is horizontal. In Fig. 18 let CA and EB be two adjacent frames, AM and BN the corresponding molded lines of the margin plate, and AB the molded margin bar. As before, apply the bevel stick to the line AB, where we find, say, 15 degrees. On each side of A lay off 4 inches to the points P, and with scale "D," also on each side of A, spot the two points P' at 15. Then erect the two perpendiculars at P' to intersect the frame lines at C and M respectively. From there draw the two horizontal lines to intersect the perpendiculars from the points P, as shown. Angle $C'AM'$ is the required angle.

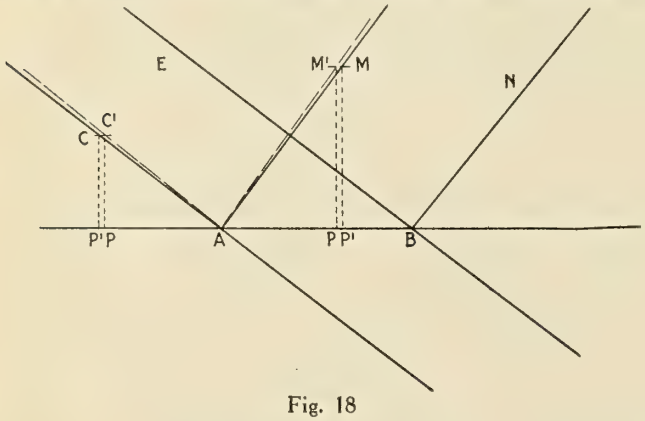


Fig. 18

From this it is seen that as AB grows shorter the angle on the body plan approaches the true angle of the bar. The loftsman, by experimenting a little, will soon learn when the difference in the two angles is enough to consider.

When the heel of the bar makes an angle with the horizontal, another element is introduced that makes the problem much more complicated, and unless the mechanic is sure of his ground it will be better to mock-up a model; but the demonstration is of interest from a mathematical point of view.

In Fig. 19 let CA and EB be two adjacent frames and AD and BF the corresponding beam lines, with AB the molded line of the deck. (The sheer is greatly exaggerated here, purposely, to show the construction of the figure more clearly. By applying the bevel stick at right angles between the beam lines it is found to be 20 degrees.) Any two lines, such as CE and DF, drawn parallel to the heel of the bar AB must be parallel to the toes of the flanges also. At A drop a perpendicular to the next beam line. Then the angle $A'AB$ will be the vertical projection of angle ϕ. To get the true size of this angle we must have a projection in the plane of the deck. In this view of the figure the distance between the beam lines da and fb, or aa', will be the expanded distance due to the sheer shown at AA', while $a'b$ equals $A'B$. Up to 15 degrees of sheer the expansion in the line AA' is enough to make only one degree difference in angle ϕ, when that angle is as much as 40 degrees; and as ϕ decreases, this difference also decreases. Therefore in all ordinary cases the sheer may be neglected in determining ϕ. Simply apply the bevel stick along the line $A'B$ with the end at A and read, say 40 degrees, at B.

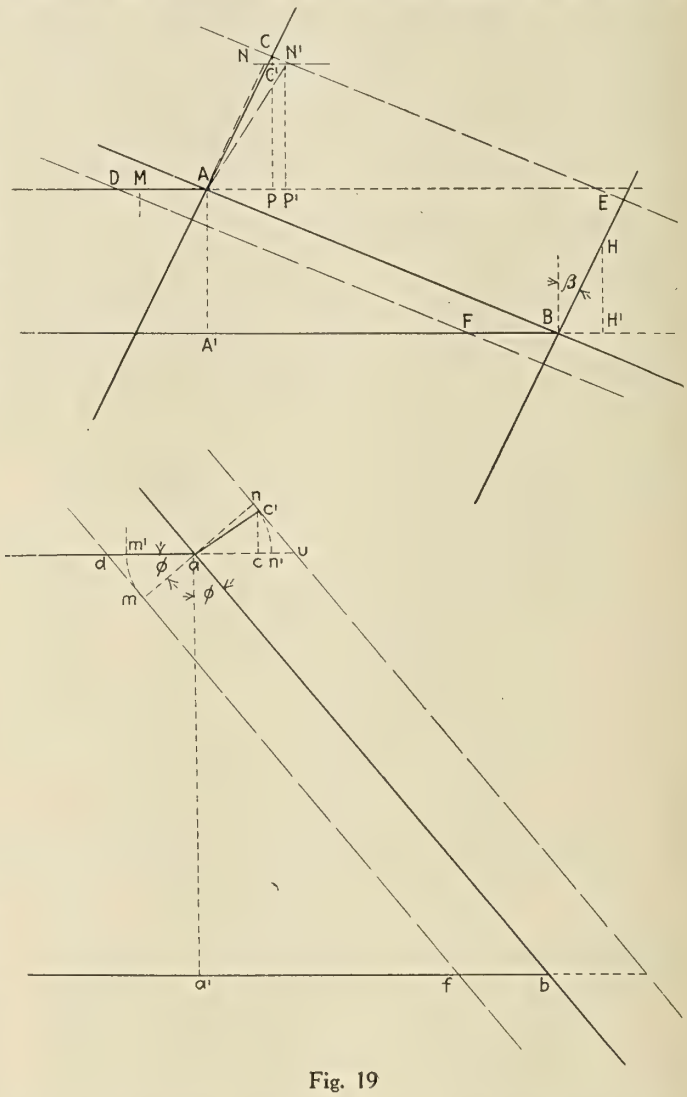


Fig. 19

As before, the problem is to find the true size of an angle made by the intersection of a plane through the bar at right angles to the heel, such as nam. To project the true size of this angle into the vertical it is first necessary to rotate it so that it stands parallel to that plane. If DA be used as an axis of rotation and the bar at B be raised till it lies horizontal, then the lines AB and DF will coincide in the line DA produced. During this operation the point C will move forward through an arc of 20 degrees, with PC as the radius. At the same time the vertical projection of the point C will drop in the perpendicular line PC to C', so that $CC' = PC$ (1 — cos 20 degrees). Then the line CE in its new position will be horizontal through the point C'.

In the horizontal projection c moves to c', so that $cc' = PC$. sin 20 degrees.

By measuring PC and applying it directly to the bevel board these distances may be found and the figures constructed as shown. Then dac' is the projection on the deck of the angle DAC, which in the horizontal is the straight line dac.

As in Fig. 17 the angle may now be revolved around a

vertical line through a as an axis. Then N moves to N' and $N'AM$ is the required angle.

An examination of Fig. 19 shows the following conditions:

$$AP = ac = au - cu.$$
$$AP' = an' = an.$$

In the small triangle $c'cu$

(1) $cu = cc' \cdot \tan \phi$,

and in the triangle not shown, in which cc' is one leg and PC the hypothenuse,

(2) $cc' = PC \cdot \sin S$, where S is the angle of sheer in degrees.

Substituting (2) in (1) we get:

(3) $cu = PC \cdot \sin S \cdot \tan \phi$.

In triangle anu

(4) $an = au \cdot \cos \phi = (ac + cu) \cos \phi$;

then

(5) $an = (AP + PC \cdot \sin S \cdot \tan \phi) \cos \phi = AP'$.

If PC be made 6 inches long, the quantity $PC \cdot \sin S$ will be given by scale "C," Fig. 15. The distance AP can be measured on the body plan. That leaves the two unknown variables, $\tan \phi$ and $\cos \phi$, to be determined. These values may be taken directly from a set of tables and AP computed; or, if there is no book of tables handy, two more scales may be constructed as follows:

In Fig. 8 measure 4 inches out on the base OB from O and erect a perpendicular. With the end of the 6-inch pocket piece on the base pick up the points of intersection on this perpendicular and number them with the degree of angle as was done with the bevel sticks. Call this scale "E."

Again, with a radius of 6 inches and O as a center, Fig. 8, strike an arc and erect a perpendicular to the base of the point where the arc crosses. Then the value of $6\ (1 - \cos S)$ will be the horizontal distance from this perpendicular to the intersections of the arc with the various radii. This will be scale "F," and from it the value of CC' in Fig. 19 is read direct. It shows, also, that the distance CC' in all small angles of sheer may be neglected.

Since scale "D" is based on the formula $(4 \div \cos \phi)$, the cosine of any angle may be found by dividing 4 by the length of the scale out to the number of the degree required. In the same manner $\tan \phi$ is obtained from scale "E."

To find the bevel of a bar inclined both to the horizontal and to the vertical planes, proceed as follows:

Draw a perpendicular to the horizontal line DA, produced to meet the frame in the point C, so that PC equals 6 inches. With the end of scale "F" at C spot point C' at 20, the degree of sheer. Through C' draw a horizontal line.

In equation (5) $AP' = (AP + PC \cdot \sin 20 \cdot \tan 40) \cos 40$. Measure AP on the body plan; measure $PC \cdot \sin 20$ on scale "C"; find $\tan 40$ by dividing 4 into the distance to point 40 on scale "E"; and for $\cos 40$ divide 4 by the distance to point 40 on scale "D." Then equation (5) becomes:

$$AP' = \left(3\tfrac{1}{8} + 2 \times \frac{3.5}{4}\right) \frac{4}{5.25} = 3.9 \text{ inches.}$$

Measure this distance out to P' and erect the perpendicular to intersect the horizontal line through C' at N'. Then $N'AM$ is the angle sought.

To read the bevel in degrees of this or any other angle, such as EBF, Fig. 19, measure 6 inches along the line BE from B to H and drop a perpendicular to the other leg produced. Place scale "C" on BH', with the end at B, and read the degrees at H'.

The value of AP', as given in formula (5), applies only to the outboard flange when the sheer is rising toward the stem in the forward body and toward the stern in the after body. If the inboard flange, also, is inclined to the horizontal under these conditions of sheer, the formula, when applied to that flange, becomes:

(6) $AP' = (AP - PC \cdot \sin S \cdot \tan \phi) \cos \phi$.

When the sheer is reversed, the formulas are interchanged; that is, apply (6) to the outboard flange and (5) to the inboard flange.

Electrical Propelling Machinery on the Eclipse Gives Satisfactory Performance on Maiden Voyage

INTERESTING facts on the operation of the S. S. *Eclipse*, America's first electrically propelled merchant vessel, are given in a recent letter to the General Electric Company by A. Starr, engineer of the Locomotive Superheater Company, New York, upon his return to this country after being aboard the *Eclipse* from New York to Port Said, on her first run. In his communication, Mr. Starr says:

"The trip was the most interesting in all my sea experience, making 5,122 miles without a single stop. Although we have had very heavy weather and a poor grade of fuel, we maintained excellent speed for the entire trip.

"The main turbine and motor gave excellent service, the control gear was very easily and efficiently operated by the new personnel, not the slightest trouble of any kind was experienced during the run.

"The boilers and superheaters gave very satisfactory results, maintaining a pressure of 200 to 210 pounds, and a temperature of 585 degrees to 600 degrees at the turbine.

"The chief engineer was very well satisfied with the performance of the entire equipment and especially so, with the simplicity of its operation. The engineer's force of this vessel is not above the average in experience, therefore, when we consider these facts and circumstances, together with the performance of the vessel, it is safe to say that no shipowner would make any mistake by equipping his ships with this type of equipment.

"The engineers on watch operated the apparatus as easily as a motorman does a trolley car; each and every one showed an interest in his respective duty, which was due chiefly to the simplicity of operation, which also created a very harmonious atmosphere, with co-operation and everybody pulling together for the best results.

"The vessel went through some very rough seas, and when the stern was pitched high up out of the water by the heavy swells there was not the least variation noticeable in the revolutions of the main motor and no vibration was felt at any time in any part of the ship during the trip.

"The writer has had many years of seagoing experience in different types of vessels with various equipments, but has never been on any vessel which showed such marked steadiness and entirely devoid of vibration.

"I wish to add that the congenial and harmonious feeling among the entire crew would be hard to find on any ship, which I would say was due to the satisfactory performance and results shown. On our arrival at Port Said, everybody seemed very happy and everything was ready to go ahead to Singapore."

Does Everybody Know?—"Everybody knows," says Senator Edge, "that we cannot be prosperous in this country by attempting to confine the absorption of the products of the country within our own borders. We must do business with the world." But *does* everybody know it? A hundred and one general panaceas have been brought forward as the one best antidote for depression. When everybody finds out that we must do business with the world, and works toward that aim, then and then only will our surplus goods find a way to market.

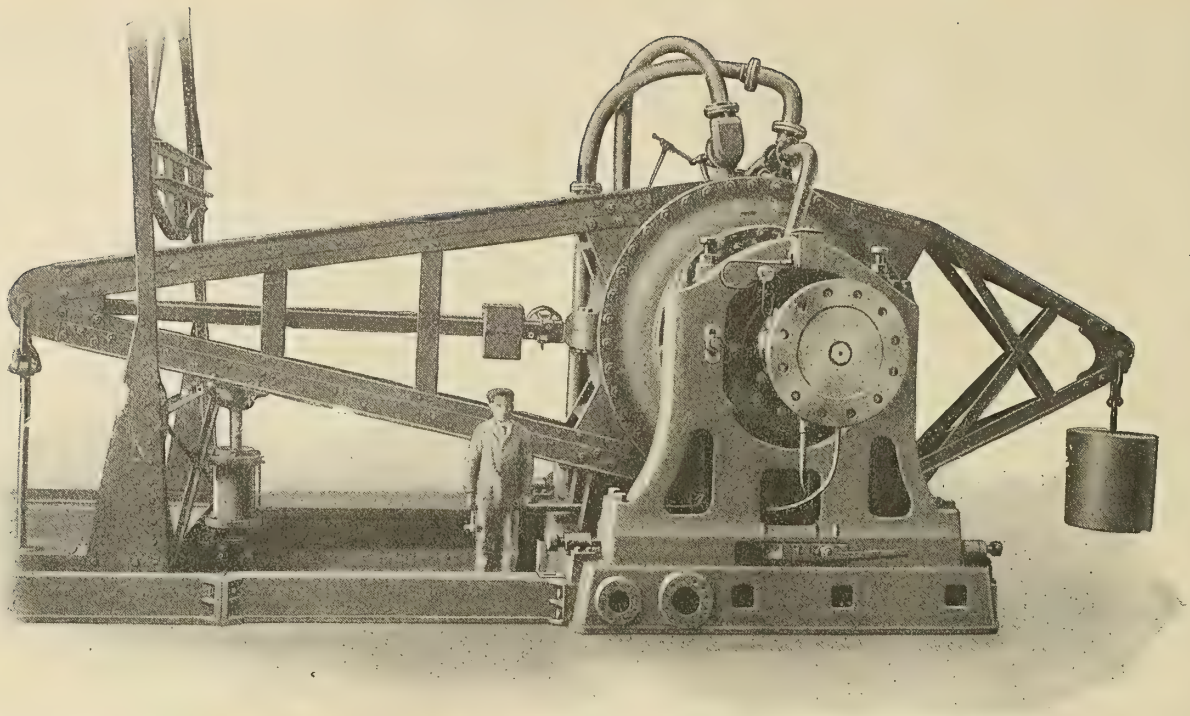


Fig. 1.—Froude Non-Reversible Standard Low Speed Dynamometer, with Rated Maximum Capacity of 6,000 Brake-Horsepower at Speeds of From 100 to 140 Revolutions Per Minute

The Froude Hydraulic Dynamometer

Reversible and Non-Reversible Types Built in Standard Sizes up to 6,000 Horsepower by the C. H. Wheeler Manufacturing Company

BY C. H. PEABODY, DR. ENG.

THE Froude hydraulic dynamometer applies on a grand scale the principle used by Joule in his determination of the mechanical equivalent of heat; Joule used the ordinary physicist's calorimeter, a thin cylindrical metallic can placed on a table. From a frame above came down a vertical shaft carrying a fan with many radial blades. The shaft was driven by cords running over pulleys and carrying weights at the ends. Around the inside of the shell of the can were partial radial partitions which caught the water and aided in churning it. There were provisions for winding up the cords, for checking loss of heat and measuring the rise of temperature of the water. Rowland improved the method by hanging the calorimeter can so that it could turn about the axis of the shaft; then he provided means for preventing rotation of the can and for measuring the torque. He consequently had a small dynametric calorimeter and he drove it from a gas engine.

Froude's hydraulic dynamometer differs from Rowland's dynametric calorimeter in three ways: (1) The shaft is horizontal and carried in bearings for convenience in construction and in application to motors which habitually have horizontal shafts; (2) the dynamometer is large and strong and can absorb large power; (3) there is a continuous flow of water through the dynamometers to carry away the heat generated.

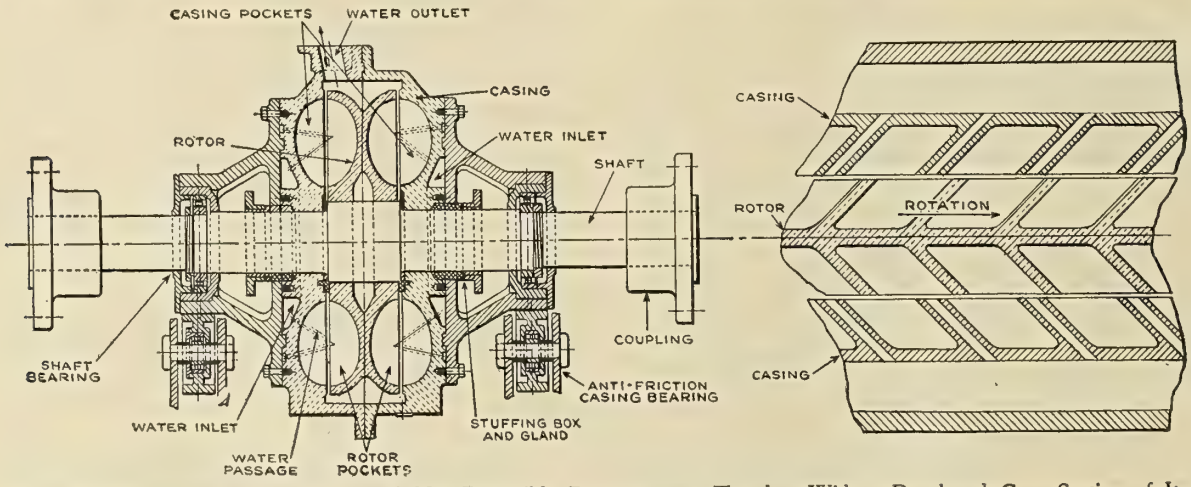


Fig. 2.—Diagrammatic Cross-Section of Non-Reversible Dynamometer, Together With a Developed Cross-Section of Its Principal Water Passages

Fig. 1 gives an external view of the Froude standard low speed dynamometer to absorb 6,000 horsepower at 100 to 140 revolutions per minute; the mechanic standing near gives the scale. Fig. 2 shows a vertical longitudinal section through the axis. A study of these two figures and also of Fig. 3 will make the construction and action of the machines evident.

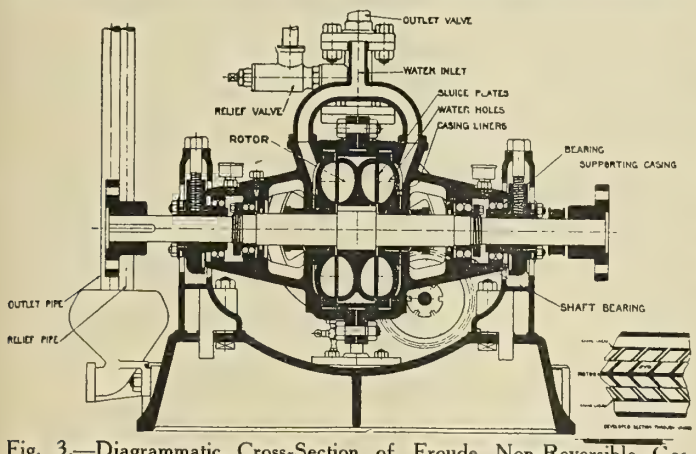


Fig. 3.—Diagrammatic Cross-Section of Froude Non-Reversible Gas Engine Dynamometer, Together With a Developed Cross-Section of Its Principal Water Passages

It should be noted that the two latter figures represent different machines. In the first place, we note the shaft in Fig. 2 and Fig. 3 which has flange couplings at each end so that the machine is both right and left handed and can take on any motor to which it is adapted. At the middle of its length the shaft carries the rotor with half elliptical cups; opposite these cups are similar cups in the casing turned the other way, as is shown by the developed cylindrical section through the cups at the right. The shaft passes through stuffing boxes and is supported in bearings in the casing; the casing in turn is supported by pedestal bearings. Thus the shaft runs freely in its bearings and the casing is free to turn in its bearings, except as it is held in place by the device for measuring torque.

Water is supplied by a pipe which comes up through the floor in Fig. 1 and branches to both ends of the casing, as shown in Fig. 3. The water passes from the ends of the casing through the slots between the fixed cups, as shown in the cylindrical section, then into the cups of the rotor and is thrown back and forth between the moving and fixed cups and escapes at the outside of the casing near the middle. The water is delivered by the pipe shown in Fig. 1, running up over the branched inlet pipe and then turning down. The inlet pipe has sufficient flexibility to allow freedom of motion to the casing; the outlet pipe delivers through an open end into a tunnel.

The shaft in Fig. 2 has plain bearings and the casing has anti-friction bearings that are not well shown. Fig. 3 shows the machine equipped with ball bearings.

The casing is prevented from rotating, as shown in Fig. 1, by an open frame which carries a scale pan for receiving weights at the end of the long arm. There is a sliding weight for finer adjustments. There is a dash pot to check irregular movements and a counterbalance weight on a short arm beyond the shaft.

All the frictional resistance of the shaft in the glands and of the shaft in its bearings is applied immediately to the casing and is measured as torque, together with the torque due to churning the water. There remains unaccounted for only the friction of the casing on the pedestals, and this develops only a negligible amount of work because the casing, while free in its bearings, is held in place by the frame and its weights. Consequently the Froude dynamometer gives an accurate and correct determination of the power received from the motor. The weight of the shaft, rotor and casing is all carried by the dynamometer itself and there is no load to transfer back to the engine bearings.

There are three elements that enter into the computation of power: (1) The length of the arm carrying the weights measured from the axis of the shaft, which is determined by the construction of the machines; (2) the weights hung on the pan; (3) the revolutions of the shaft, this last being determined by aid of a counter driven by the shaft.

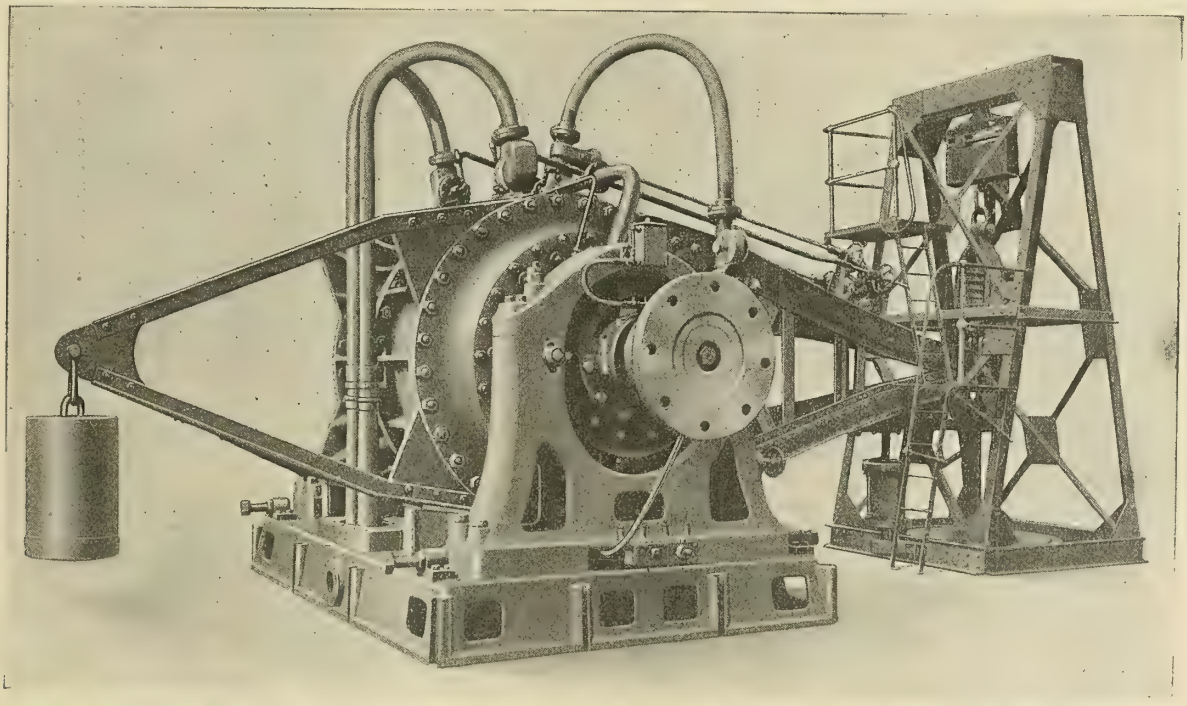


Fig. 4.—Froude Reversible Low Speed Dynamometer, with Rated Maximum Capacity of 4,000 Brake-Horsepower at Speeds of From 125 to 180 Revolutions Per Minute

Let W be the weight in pounds, R the revolutions per minute, and L the length of the arm in feet. Then the brake horsepower is computed by the formula

$$B.H.P. = \frac{2\pi L \times W \times R}{33{,}000} = \frac{WR}{K},$$

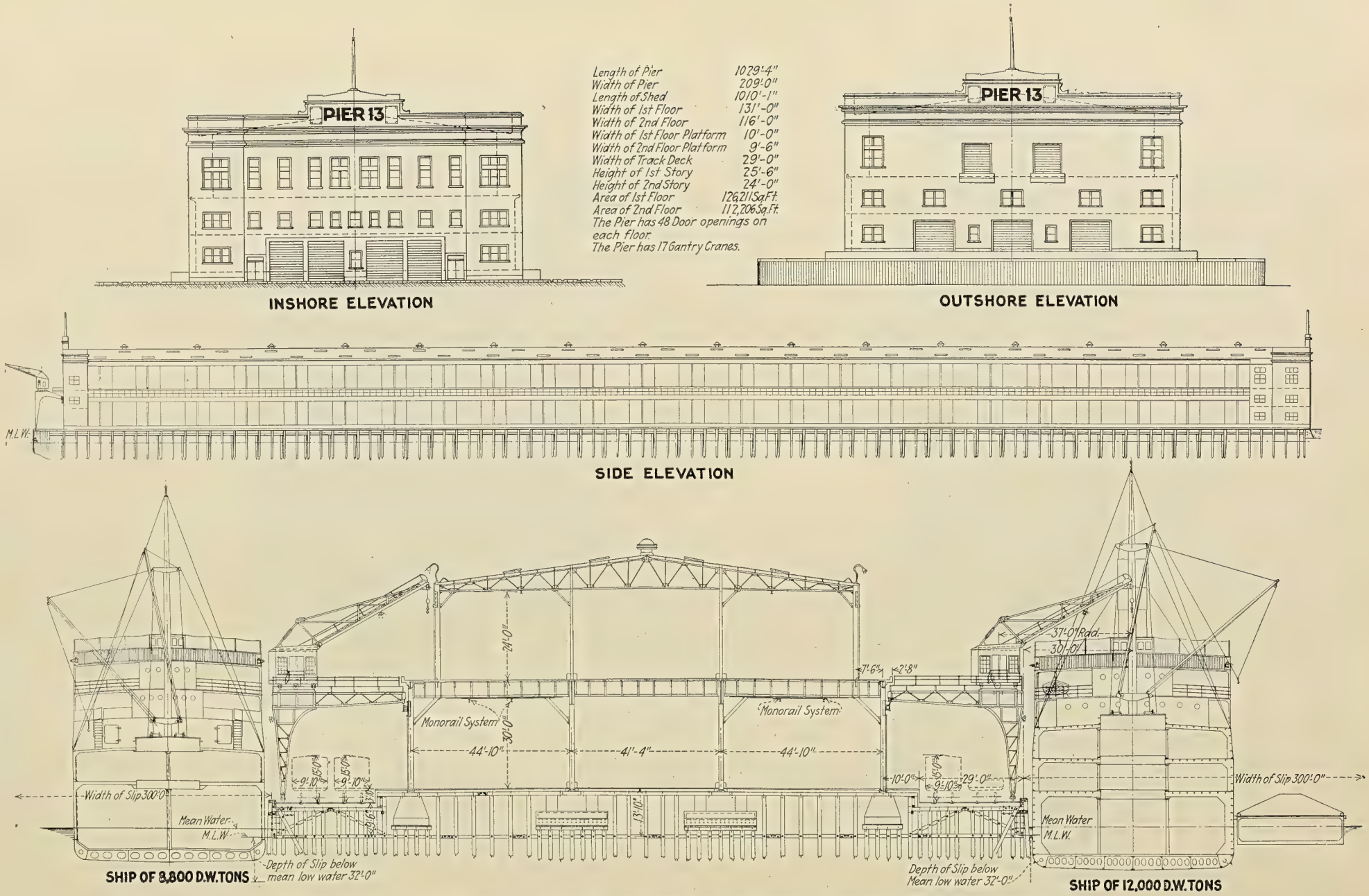


Fig. 1.—General Arrangement of New Staten Island Pier, With Two-Story Shed and Mechanical Freight-Handling Equipment

where K is the machine constant supplied by the makers.

The dynamometers considered are single acting and can be driven only one way, though they can be adapted to either right or left handed rotation. Fig. 4 shows a dynamometer of 4,000 horsepower that can run in either direction arranged so that the torque is determined by a weighing machine.

The load imposed by the dynamometer is determined by the amount of water passed through the machine. The larger amount of water there is passed back and forth between the caps of the rotor and the casing, the greater the power absorbed. In order to get a steady load, it is important that the water pressure supplying the dynamometer should be steady. The readiest way to obtain this result is to have the supply come from a special open tank which may be filled automatically from the general water supply. This is particularly important at reduced powers because an interruption or a sudden reduction of the water supply may make the dynamometer jump or even allow the engine to run away. Engineers using the hydraulic dynamometer should determine whether and under what circumstances there may be danger of jumping and avoid approaching a dangerous limit.

The Froude dynamometer is made in various standard sizes suitable for testing motors of all sorts, from automobile and airplane engines up to marine and stationary engines of 6,000 horsepower. There are also made machines for running in various motors under full or reduced loads. Such brakes are not supplied with measuring devices, but each machine is supplied with an approximate capacity curve so that it may be adapted to any desired operation.

The New Piers at Staten Island

General Arrangement and Equipment of Twelve New Piers to be Added to the Terminal Facilities of New York Harbor

BY FLOYD T. SMITH*

NEW YORK City will soon have twelve more piers. Work has already been started and some of the construction is well under way. Considerable has been written about the apparent disregard of present-day practice in terminal design of these piers and the lack of proper forethought in planning for the future, thereby suitably providing for the rapidly increasing trade and furnishing adequate equipment for handling the growing export business. It is a keen disappointment to many that the great Port of New York, with its enormous amount of shipping, can not boast of the finest piers in the world and point with pride to this terminal as a complete unit, as one that is the last word in design, modern in wide pier construction with adequate warehouse and shed capacity, with rail connections and supplied with the latest freight-handling equipment as a means of insuring a ship's quick turn around.

The marine terminal is naturally an outlet to the sea for the railroads and generally the railroads are necessary and attendant to it. The supply of commodities throughout the country demands an outlet and the imports require a receiving point for distribution inland. Unloading and loading imports and exports are very different. The two are very much unlike. What features, therefore, are vital to a modern terminal? They might be outlined as follows: Location, rail connection, commodity handled, type of construction and handling equipment installed.

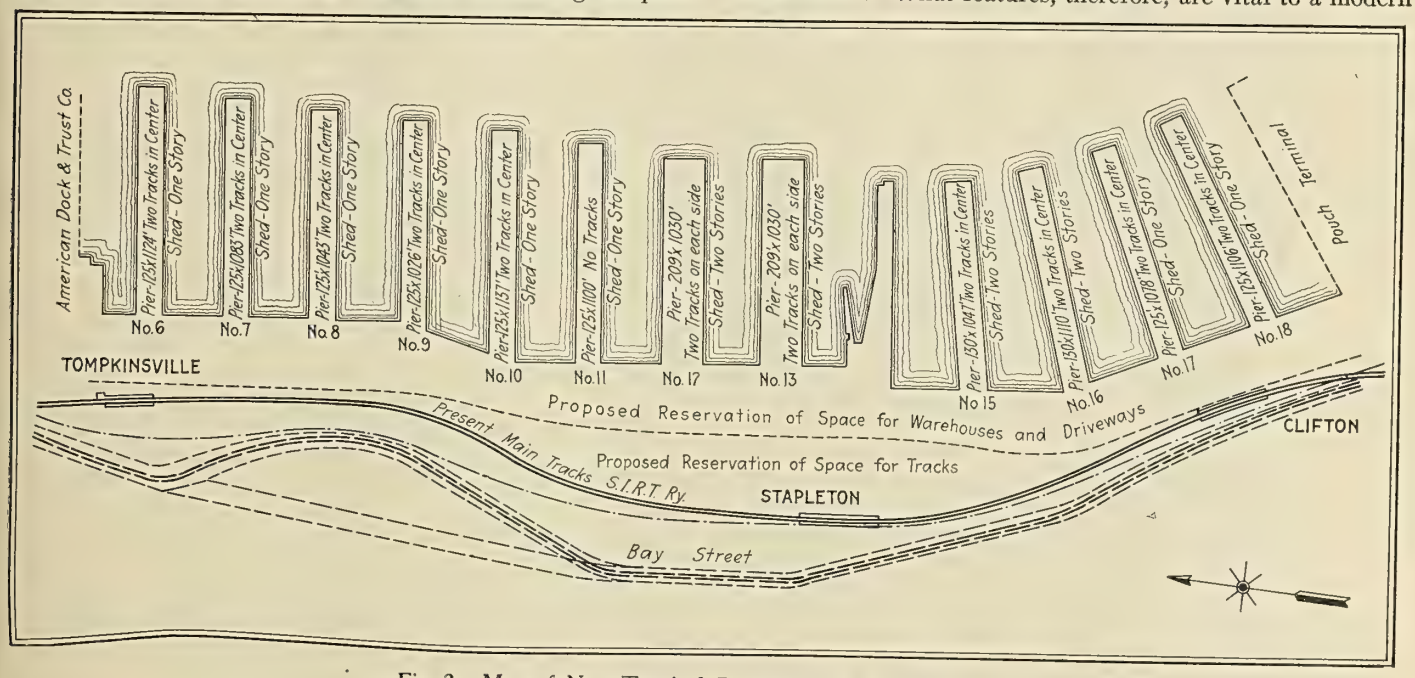


Fig 2.—Map of New Terminal Development on Staten Island

Advantages of New Staten Island Piers

The piers at Staten Island will have many natural advantages. They will have the advantage of being located somewhat nearer the ocean than the present piers on Manhattan and the piers immediately adjacent to it. They will be situated on the north side of Staten Island, just inside the Narrows and facing New York. They are on the west

* Power and Mining Department, General Electric Company, Schenectady, N. Y.

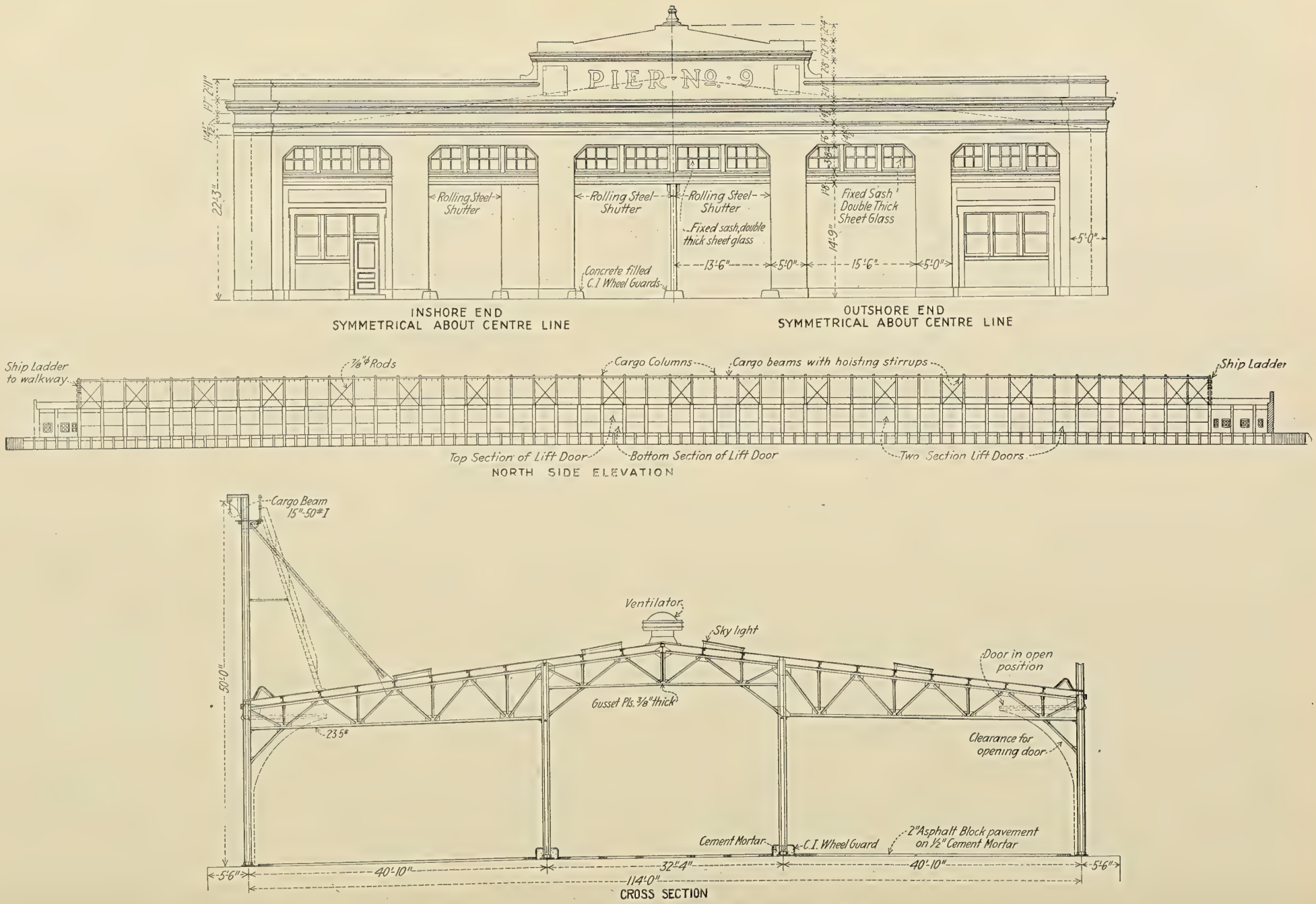


Fig. 3.—Sections and Elevations of Pier With One-Story Shed

side of the river, adjacent to the mainland, thus saving extra transfer of the majority of freight by lighter. They have the advantage also of direct rail connection which was not possible except in a more or less indirect way with the present piers on Manhattan.

The piers will be connected by rail with the Baltimore and Ohio Railroad, and it is expected that proper track layout will be made furnishing an enlarged railroad yard and in turn connecting with the tracks on the piers. It is possible and a very great advantage to make connections with a trunk railroad line crossing New Jersey. Such connections can be made not only with one trunk railroad but with all of the following: Pennsylvania, Reading, Central of New Jersey, Erie, Delaware and Lackawanna, Lehigh Valley and West Shore. This would give a very important and valuable rail connection with every part of the country.

Comparison With Terminals at Other Ports

A comparison of the Staten Island piers with the largest terminals at other ports shows the following: At Staten Island—two piers 209 feet wide and 1,330 feet long; two 130 feet wide and approximately 1,047 feet and 1,110 feet long; eight 125 feet wide and 1,026 to 1,130 feet long; at Seattle, Smith's Cove Terminal—Pier A 2,530 feet long and 310 feet wide; Pier B 2,580 feet long and 367 feet wide: Portland, Oregon, pier 1,350 feet long and 480 feet wide; Boston, 1,200 feet long, 400 feet wide; Montreal, 1,250 feet long, 300 feet wide; Philadelphia, 1,200 feet long, 300 feet wide; San Francisco, 981 feet long, 200 feet wide; Baltimore, 1,450 feet long, 200 feet wide.

General Arrangement

Two piers will have two railroad tracks on each side of the piers; one pier will be built without provision for tracks and eight piers will have two tracks in the center. The railroad tracks will be depressed so that the floor of the shed will be on the same level with floor of cars, which greatly facilitates the handling of freight.

Four of the piers will have two-story pier sheds and the others will have sheds of one-story construction. However, three forms of construction will be adopted, i. e., the single-story shed, a double-story shed and a double-story shed with provision for crane equipment.

Two piers will have cargo crane equipment. The pier sheds not provided with cranes and provision for a loading platform around the second floor of the shed will have the familiar cargo masts and will be furnished with two-ton winches that will be conveniently placed so as to be used in connection with the cargo masts for rapid unloading.

The slips will be uniform in size, 300 feet wide, which allows two ships with a lighter alongside of each to berth and still have a passage way between for a lighter.

The piers and pier sheds will be well supported by warehouses at the shore end and these warehouses, as well as the two-story pier sheds, will be provided with elevators.

One pier to be occupied by the International Mercantile Marine will not be furnished with equipment, not even railroad tracks. And while this is not an indication in any sense that this is proper pier construction, yet it would be expected that with its many years' experience in cargo handling, such a concern would naturally use advanced methods or perhaps adopt means somewhat ahead of present-day practice, rather than ignore the results the use of mechanical apparatus will accomplish.

It may be said, however, that the new cargo ships are generally provided with winches, which is one reason why no extensive mechanical equipment is to be provided on most of the piers which will nevertheless be furnished with cargo masts designed to operate in conjunction with a ship's cargo handling equipment.

The principal points of disagreement of the type of construction adopted for the several piers are: narrowness of the piers, failure to provide track facilities on the piers and lack of cargo handling machines. Favorable and unfavorable comments have been made for both forms of construction but the wider pier which provides means for storage and releases railroad cars for other service seems the one more universally adopted. Furthermore, if direct loading and unloading is to be done, two tracks at the sides and the cranes spanning them, allow the cars to be run to the ship's side, which gives an interchange of cars loaded and unloaded and permits ready and quick unloading from the ship to car and vice versa.

Piers Leased by Pan-American Terminal and Dock Company

Of a total of twelve freight piers to be erected by the city the two leased by the Pan-American Terminal and Dock Company are notable exceptions. It is proposed to have installed on them the most modern freight handling machinery such as revolving cranes outside the sheds and monorail hoists or traveling cranes inside the shed, together with elevators. There will be two 20-ton truck elevators and two 10-ton freight elevators.

It is proposed to install 17 electrically operated wharf semi-portal cranes located on each pier of design as shown in Fig. 1. The capacity of the cranes will be approximately 5,600 pounds on the hook, with a hoisting speed of 125 feet per minute. Each crane will be fitted with a cable on a self-winding reel and a controller for the use of magnets when handling iron. The cargo will be taken from the ship's hold and delivered to the first and second floors of the pier shed. In loading the cargo is taken from either the first or second floors and delivered to the ship.

It is estimated that a crane should be able to make 40 full operations per hour, which with an average load of 2,500 pounds would move about 44½ gross tons of cargo, and for a ship with four hatches would give 178 tons per hour or 1,424 tons per day of eight hours. Each pier is to accommodate 4 of the 10,000-ton standard ships at one time and besides this there is ample space for several lighters and barges. This would indicate a turn around of about 34,000 tons of cargo per week of 6 days, but on account of lost time in shifting ships, the estimated turn around for each pier should be about 25,000 tons per week. The amount of cargo being loaded or discharged will be about the same. About 60 percent of this will be handled from the first floor and railroad cars while the remaining 40 percent will be handled from the second floor.

The total area of one pier is about 242,000 square feet with about 161,000 square feet available for storage of cargo and when the same is piled to an average height of 12 feet there will be space for about 49,000 tons of 40 cubic feet per pier.

The cargo will be handled inside the pier shed by overhead monorail hoists of which there will be approximately 20 on each pier. The capacity of the monorail hoists will be approximately 5,600 pounds on the hook with a hoisting speed of 70 feet per minute ,and a travel speed of 350 feet per minute.

It is estimated that each of the monorail hoists should be able to make about 32 full operations per hour, which speed should insure handling of the same amount of cargo inside the shed as the cranes are able to handle outside the shed.

Eight Piers Leased to Date

The readiness with which the piers have been leased shows that, although they are more than 10 miles from New York City hotels and shipping districts near where passenger lines

always had docking faculties, this distance will not prove a disadvantage.

The following companies have made definite arrangements to use these piers and have signed leases for a number of years:

Pier No. 6.—Green Star Steamship Company.
Pier No. 8.—Wesel Deval & Company.
Pier No. 9.—Moore and McCormack.
Pier No. 10.—Raporel Steamship Line.
Pier No. 11.—International Mercantile Marine.
Pier Nos. 12 and 13.—Pan-American Terminal and Dock Corporation.
Pier Nos. 15 and 16.—Union Transport Company.
Pier No. 17.—Compagnie Generale Transatlantique.

Mechanical Handling vs. Old Method

Some hesitate to believe the results that have been accomplished at many of the modern ports in which mechanical equipment has been installed. As an illustration of what can be done by developing the use of mechanical equipment a comparison of two cargoes handled in the last few months at Smith's Cove Terminal in Seattle, one of the largest and most modern of the newer terminals, is of interest.

On March 13, in a cargo from the *Mandansan Maru*, there were 2,398 tons or 11,937 barrels of oil. The cost of handling and stacking this barrelled oil two tiers high on the pier was 45 cents a ton or 9 cents per barrel, the cargo being handled by the old method of hand truck and piling.

On June 13, with the use of mechanical equipment there was unloaded from the *City of Spokane,* 1,730 tons of barrelled oil or 8,612 barrels. The cost was reduced to 33 cents per ton or 6.6 cents a barrel and the barrels were piled three tiers high.

Taking the same vessels unloading dry cargo; on March 13 there were unloaded from the *Mandansan Maru* 1,000 tons of beans, rape seed and maize at a cost of 39 cents per ton. This material was handled by two wheeled trucks.

On June 13 there was unloaded from the *City of Spokane,* 3,000 tons of bean cake and sugar, handled by tractors, trailers and loading platforms at a cost of 20 cents per ton, a saving of practically 100 percent on dry cargo. This is just an indication of what the future holds on reducing cost of handling freight by means of mechanical equipment.

The mechanical equipment contemplated for inside the pier shed on the Staten Island piers, such as industrial storage battery trucks and tractors, mechanical piling machines and portable conveyors, remains a conjecture, but it is fair to assume that with results in mind that have been accomplished elsewhere the operating companies, profiting by experience and fully aware of the surprising results that can be accomplished, will use modern equipment.

It has been stated that in assuming the approximate cost for the 125-foot one-story pier as 100 percent, the approximate cost of the 209-foot two-story pier with the mechanical equipment will be 251 percent, showing a difference of 151 percent. It is naturally expected that this increased cost will be more than justified by the rapid loading, gain in earning power and more rapid ship turn around.

Unfortunately, the construction of the piers and pier sheds that will not use the overhead traveling cranes or monorails inside the sheds is such that should later events demand more adequate methods of handling the structure will not support it.

Whether the form of construction adopted is a wise move, the future will confirm or disapprove.

Current Shipping Board Expenditures Will Influence Our Future Merchant Marine Policy

(*Continued from page* 233.)

vessels on the active list, there was a suggestion that it might be the proper course to tie up the entire fleet forthwith. Shipping Board officials have opposed this as unwise and to an extent impracticable. For one thing it has been pointed out that the expense of tying up the fleet would run, according to estimate, in the neighborhood of $8,000,000 a year. Furthermore, a number of the ships are at foreign ports or on distant trade routes and would have to be returned to United States ports in any event. Shipping Board executives, in conference with the leaders of Congress, have urged that the preferable policy is for the government to, for the time being, take its losses, just as private vessel owners are doing and stand ready to recoup when commerce revives. The opinion in this quarter, quoted for what it is worth, is that shipping conditions will be back to normal in six or eight months.

It is the disclosures as to current losses in the operation of Shipping Board vessels that has been responsible, more than anything else, for the development of the existing tense situation between Congress and the Board, with respect to the policy on uncompleted contracts for vessel construction. Restless, in the face of a ship operation deficit running close to $50,000,000 a year, the leaders of Congress have been visibly irritated by the disclosure that Commander R. D. Gatewood, director of construction and repairs of the Shipping Board, sent, as of comparatively recent date, communications to shipbuilders holding government contracts urging them to expedite the work in hand. It did not help matters that Commander Gatewood explained that it was his idea to speed up construction in order that the entire building programme might be completed so far as possible prior to the beginning of the new fiscal year on July 1, 1921.

Completion of Vessels Under Construction

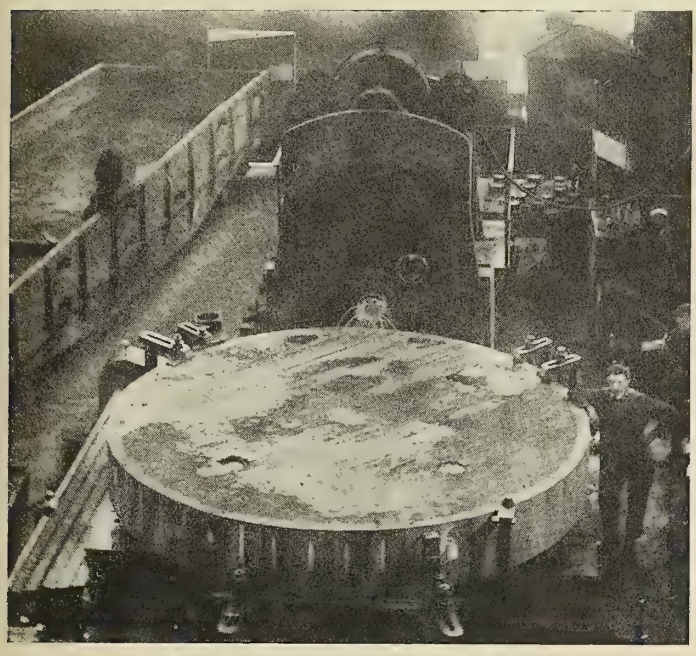
In the discussions that have continued at the Capitol since the middle of January, the Shipping Board has, in effect, been continually on the defensive for its policy of sustained vessel construction. Shipping Board executives stick to their guns with the defense that regardless of whether or not the government needs or wants more ships, it is more economical to complete the vessels now at the shipyards than to make cancellations. On this point Commander Gatewood recently declared: "Almost all the material for these ships has already been purchased and most of it paid for and is in the yards of the contractors, taking up valuable storage space, and the material ought to be put into ships so we can get rid of the heavy overhead of construction and get the ships either laid up or into service.

"The programme has been strung out too long now. Some contractors in their desire to reduce their forces after the armistice, which was a very warranted desire and a very worthy desire, in some cases reduced too much and in other cases they shifted their forces over to some more profitable private work, thus leaving our programme to suffer in spots. I want to say that these vessels ought not to be stopped because if they are stopped it will result in a very heavy loss. Stopping the ships on this programme for even a day will cost around $150,000 per day. If the programme is allowed to go ahead, it can be finished up and we will be taking advantage of the increased efficiency of labor and of any wage drop that may occur. We can get rid of the overhead on construction and our own overhead in that way and make more money by going ahead than we could by stopping at this time."

The World's Largest Gyroscope

THIRTY years ago gyroscopes were looked upon only as mystifying toys for the children or by scientists as a means of displaying or developing their knowledge of higher mathematics when theorizing on gyroscopic laws and reaction.

Then gyroscopes never "grew" more than a few inches in diameter. But about this time Mr. Elmer A. Sperry, a scientist of renown in many branches of engineering, set himself to employ the interesting peregrinations of the gyroscope to some good uses. So successful have been his efforts that already over one thousand of the world's naval vessels, and during the last year upwards of one hundred merchant ships, have been equipped with the gyro compass. The earth's rotation is thus employed for navigation, the little gyros giving a powerful and accurate true north indication.



Machining 90,000-Pound Gyro Rotor

A newer and more interesting application to the traveling public is in the use of the gyroscope as a stabilizer to prevent a vessel's roll. Some twenty odd equipments have already been put in service and we take pleasure in showing here, in the process of machining, the largest gyroscope yet built. The picture was taken in the Nicetown Works of the Midvale Steel & Ordnance Company, where the huge forging, weighing over 90,000 pounds was made. When finished machined, with heavy rim, solid web and hubs for shaft stubs, this rotor, or gyroscope, will be 12½ feet in diameter and weigh 70,000 pounds, or 35 tons. Two of these rotors will be bolted together. This mass, weighing approximately 75 tons, running at 850 revolutions per minute, will stabilize a 10,000-ton cruiser enabling her to enter an engagement in any weather with level gun platforms.

A further point of interest is that, due to the omission of bilge keels and the power saving brought about by the elimination of roll and the reduction in the yawing and wallowing, the stabilizer will save several times the power required to run the gyroscope. This will enable her to use less fuel when maneuvering in smooth seas or maintain nearly the same speed in rough weather.

A 1,100-ton yacht, the *Lyndonia,* has just completed a passage to Charleston where the roll was easily quenched from 18 degrees to 3½ degrees when the stabilizer was turned on.

A number of other stabilizers are now in the process of manufacture, including equipments for various size vessels, from an 800-ton yacht to an 18,000-ton passenger liner.

The efforts of Mr. Sperry and his corps of engineers are thus reaping early results and shipping men throughout the world are looking forward, with keen anticipation, to the opportunity of observing a large passenger liner freed from roll and made independent of the elements.

Membership Campaign Under Way for the Society of Marine Draftsmen

IN order to excel on the sea and as a shipbuilding nation, the United States must have the best ship designers. Through co-operation the efficiency of American ship designers can be materially increased and it is for this purpose that the American Society of Marine Draftsmen is now entering upon an active campaign for the increase of its membership. Marine draftsmen must have up-to-date knowledge of all the latest marine appliances; they must know the best and most economical methods of design and understand their application. To acquire this knowledge, and to qualify for advancement in the profession, no better medium is offered than the American Society of Marine Draftsmen with its lectures, general discussions and its journal.

Grades of Membership

Four grades of membership are available in the society, designated as members, associate members, associates and juniors. A member must be a draftsman at least twenty-five years old, who has had at least seven years' experience as a marine draftsman and, at the time of making application, shall be actively engaged in marine or naval work. He must be of such character and standing professionally and otherwise as will promote a high standard of membership. This grade covers all draftsmen, chief draftsmen, naval architects, engineers, production managers, superintendents and men engaged in shipbuilding who can qualify by previous experience.

An associate member must be a draftsman at least twenty-one years old, who has had four years' experience in drafting and is engaged in marine or naval work but is not eligible to a higher grade of membership.

The grade of associate, which was established at the society's last annual convention, is designed to include men who are engaged in the manufacture and selling of marine equipment. An associate must be at least twenty-one years old and hold an executive position in the selling or manufacturing of marine equipment or in the operation of ships.

A junior must be a student in a recognized regular engineering or naval college or a draftsman actively engaged in marine or naval work. He must be at least eighteen years of age, but not eligible to a higher grade of membership.

Where to Apply

Application blanks for membership or any further information regarding the activities of the society can be obtained from any of the following:

Morris L. Potts, chairman, 1741 North 62d Street, Philadelphia, Pa.

R. R. Doerflinger, 65 Layton Ave., New Brighton, S. I., N. Y.

H. J. Thiede, 7411 Rising Sun Ave., Philadelphia, Pa.

M. M. Blunt, 13 Edmands Street, Winter Hill, 45, Mass.

A. D. Micotti, 312 Copley Courts Apt., Washington, D. C.

J. N. Miller, Newport News Shipbuilding & Dry Dock Company, Newport News, Va.

F. S. Dubois, P. O. Box 98, New London, Conn.

J. N. Taylor, 305 Washington Street, Bath, Me.

W. H. Walker, 46 Eagle Street, Bridgeport, Conn.

J. H. Holmes, P. O. Box 162, Bethlehem, Pa.

Marine Engineering

Published Monthly by

ALDRICH PUBLISHING COMPANY

In Conjunction With

SIMMONS-BOARDMAN PUBLISHING COMPANY

6 East 39th Street and Woolworth Building, New York

F. B. WEBSTER, Editor
H. H. BROWN, Managing Editor

S. M. Phillips, Associate Editor
A. J. Kaufmann, Associate Editor
L. S. Blodgett, Associate Editor
W. Z. Gardner, News Editor

Contributing Editors

Rear Admiral C. W. Dyson, U. S. N.
Commander S. M. Robinson, U. S. N.
Professor C. H. Peabody
Captain C. A. McAllister, U.S.C.G. (Retired)
William Gatewood
H. McL. Harding
William T. Donnelly
James L. Bates

WE GUARANTEE, that of this issue 8,100 copies were printed; that of these 8,100 copies 6,486 were mailed to regular paid subscribers, 360 were provided for counter and news company sales, 331 were mailed to advertisers; 79 were mailed to employees and correspondents and 844 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 25,800, an average of 8,600 copies a month.

Marine Engineering is a member of the Associated Business Papers, Inc. (A. B. P.), National Association of Periodical Publishers, Inc., New York Business Publishers Association and the Audit Bureau of Circulations (A. B. C.).

Subsidy

EVEN as our farmers and manufacturers must be protected by a tariff, which is no more and no less than an indirect subsidy, so must our shipping receive some sort of government aid. Fortunately, any subsidy that is given to shipping immediately places a premium on vessels built in American shipyards because the war time act which allowed the Shipping Board to grant the privileges of the American registry to foreign-built vessels has been repealed. American shipping and shipbuilding will, therefore, live or die together; and, as it is ridiculous to expect the men engaged in shipping and shipbuilding to accept a foreign standard of wages or living, the difference must be made up in some way or another.

It is all very well for us to be proud of American ingenuity and the success that we have had in the quantity production of sewing machines, automobiles, harvesting machines, etc., but a ship is not a machine; it must be erected like a building, and the amount of hand labor will always be very large. And, whatever may be the case in other industries, it is certain that the greater part of our shipbuilding talent learned their trade or profession in a foreign country. One of our leading shipbuilders has recently stated that the cost of a vessel is divided as follows; 40 percent for labor, 40 percent for material and 20 percent for overhead. Although some materials are cheaper in this country, the cost of labor is at least twice as much as it is abroad, which is a handicap that no sane shipbuilder can hope to overcome.

The first cost of a vessel is the sum upon which the ship operator must figure his fixed charges. These include insurance, depreciation and interest, a total annual charge of about 15 percent of the original investment. Comparing the present price which the Shipping Board is asking for its vessels with the market price abroad, these three items alone in the case of an 8,800-ton cargo vessel, for example, would make an annual difference in favor of a similar foreign vessel of over $100,000. It is the fixed charges rather than the wages of the sailors which constitute the greatest obstacle that the shipowner has to overcome.

Captain Paul Foley, director of operations for the Shipping Board, states that the running expenses for operating vessels is divided as follows: fuel, 43 percent; repairs, 30 percent; wages, 15 percent; deck and engine room stores, 6 or 7 percent; subsistence, 4 or 5 percent. While the wages are undoubtedly greater on American vessels than on foreign ships, it is quite possible for an intelligent American crew to more than make up this difference in the items of fuel and repairs. At any rate, the difference in wages and the eight-hour day with overtime are the result of the demands of the unions rather than the requirements of the Seaman's Act.

No doubt our navigation laws can be improved, but they are nowhere nearly as bad as they are painted, and it is foolish for us to talk of new laws until we enforce the constructive features of the laws that we have. American shipowners have the right to expect the benefits of the discriminatory custom duties imposed on imports carried in foreign vessels and the discriminatory tonnage duties on foreign vessels as provided for in the Merchant Marine Act of 1920, or *an equivalent direct subsidy*. The fact that, after our first Congress had imposed similar duties, we increased the amount of commerce carried in American vessels from 24 to 89 percent in the short time of ten years indicates how effective such a subsidy would be. But, as we have neglected to give notice to foreign governments that we intend to impose these duties and as diplomatic negotiations, particularly at this time, must be slow, it is the duty of Congress to grant an equivalent direct subsidy until the Merchant Marine Act can be enforced.

Sale of Shipping Board Vessels

EXPERIENCED shipowners appear to be of one mind in regard to several features of our future marine policy, namely, that the United States should have an adequate merchant marine, that the vessels should be owned and operated by private interests, that the Government should not allocate vessels to operators to engage in unrestricted competition with established shipowners, and that for a considerable time to come the Government cannot sell its ships at any price. The first three features ought to be self-evident. The only question about them is, are the policies to which they relate receiving our active support or is their adoption assumed as a matter of course?

While we are not prepared to admit that the Shipping Board cannot dispose of its vessels at, say, the average book value of English ships, it is certain that it cannot sell these vessels at anywhere near the price it would cost to rebuild them in American shipyards. This will probably continue to be the case until a definite shipping policy is adopted and, further, it must be such a policy that capital will be reasonably assured that it can operate the ships at a profit on the cost price. In view of the present business depression, it is perhaps just as well that the Government did not sell its ships even at a reduced price, as a large number of failures have thereby been averted. Again, no reasonable price can be placed on an American vessel until it is known whether

the Government is going to enforce the discriminatory features of the Merchant Marine Act, grant an equivalent direct subsidy or compel our shipowners to run our merchant marine with foreign crews on a foreign standard of wages.

The Foreign Trade Financing Corporation

THE formation of The Foreign Trade Financing Corporation under the provisions of the Edge amendment to the Federal Reserve Act, for the purpose of providing long term credits to purchasers of American goods, promises to afford to Europe, Asia, Africa and South America the opportunity to purchase the raw materials and manufactured products that they need on a straight business basis.

As the law provides that such corporations may issue bonds and assume liabilities up to ten times their capital stock, this $100,000,000 corporation can handle business up to the value of $1,000,000,000. The welfare of the country demands the development of our foreign trade because we are now producing raw materials and manufactured goods far in excess of our wants and the rest of the world needs our surplus badly. Many of our ships now lying idle will be needed to transport these products to the ports of the world and bring back goods in return.

Corporations of this sort can not entirely solve the problem of making a foreign market for our products. Serious consideration must be given to what effect a high protective tariff would have on countries that are disposed to buy our products. We can, of course, artificially raise the prices for the producer in the home market, but it is evident that we cannot sell to other countries, if the prices established by ourselves are materially higher than the general world prices based on the law of supply and demand.

America Not Over-Supplied With Ships

THE United States is still carrying less than 50 percent of its imports and exports in its own ships, the figures furnished by the Shipping Board for 1920 being 42.7 percent in American and 57.3 percent in foreign bottoms. As only a very small percentage of American vessels are engaged as feeders or assigned exclusively to routes between foreign ports, these figures show that our ocean-going tonnage, in spite of its great recent growth, is by no means too large for the requirements of our country, which should rightfully carry somewhat more, rather than somewhat less, than fifty percent of its overseas commerce.

Although the employment situation in this country demands the marketing of our surplus raw and manufactured products in foreign countries, although large financial corporations are being formed to extend long-term credits and help foreign buyers to purchase our products and although Section 28 of the Merchant Marine Act provides for the extension of preferential rail rates to goods carried in American bottoms, we are continually tying up our ships and releasing the crews recently trained in seamanship to engage in any occupation that they can get.

We all realize that an American merchant marine is necessary to the successful development of our foreign trade, and that the buying power in our domestic market is seriously affected by the accumulation of surplus products, yet we continue to deny to shipping even a small percentage of the protection that made possible the wonderful development of our manufacturing industry. The Shipping Board has collected accurate comparative data on the costs of shipbuilding and ship operating in this and other countries, and it ought not to take the new administration long to decide that shipping needs either a direct or indirect subsidy. If the new administration and the new Congress represent the will of the people they will grant the ship operators sufficient aid to compete with foreign countries on an equal basis and, then, it can be safely left to American ship operators to get their share of the commerce, which means still more ships.

Manning Requirements

THE number of extra men that must be carried on American as compared with foreign vessels has been repeatedly advanced as one of the principal handicaps working against the successful operation of our merchant marine. The number of the crew will, of course, depend upon the type and size of the vessel and no general percentage of the number of extra men can be given, but taking a specific example, the crew lists of 8,000-ton deadweight coal burning cargo boats under American and foreign flags are about as follows: American, 48; British, 45; Norwegian, 40; Japanese, 59. In this type of boat we require three more men than the British, eight more men than the Norwegians, and eleven less men than the Japanese.

The significant feature in the above comparison is the fact that the Japanese ship has by far the largest crew, but as their wage scale is very low, the total cost of the crew is much less than that of any other country. The Japanese, however, are noted for the minimum amount of repair work that their ships require in foreign ports. While it will probably be impossible to induce American seamen to accept the British standard of wages, we can reasonably expect a great deal more of our repair work to be handled on shipboard.

The Essentials of a Battleship

A BATTLESHIP is subject to four forms of attack—gun fire, torpedoes, bombs from aircraft, and mines. Mine fields are anchored and capital ships are not sent over them. If by inadvertence a ship strikes a mine, whether anchored or adrift, the ship cannot expect to escape; a good subdivision improves the chance, but no ship can be so designed as to resist mines and remain in action. Bombs from aircraft, if they strike a ship, may destroy the superstructure and perhaps do serious damage, but 217 bombs dropped by airplanes in an attack on the *Goeben* did not destroy her, though she lay aground for a week. Many ships, especially of older classes, were destroyed by torpedoes during the war, but no important action was determined by torpedo attack. The principal effect was deterrent, both sides being shy of maneuvers which would give a chance for torpedoes. The destroyer, though developed from the torpedo boat, is now a scout more likely to use guns than torpedoes. The attack to which a battleship in regular service is most exposed is gun fire—and gun fire is now tremendously more powerful than ever before.

The essential characteristics of a battleship are a powerful battery and good armor protection; it can strike hard and stand punishment. A compact squadron of ships having

these characteristics need not fear attack from any combination lacking them. Speed is valuable for maneuvering and is more valuable in proportion as maneuvering enters into a battle at sea. The larger the fleet the greater the chances and need for maneuvering.

Recent battleships have the essentials pre-eminently. There is no question of the sufficiency of a battery of twelve 16-inch guns. As for armor, it is to be remembered that the *Warspite* remained in the line after receiving twenty heavy shells. The battle cruiser has shown greater resistance than could be expected. In the battle of Jutland twelve battle cruisers were hit 150 times; on the other hand, three British battle cruisers vanished from the field of battle. Battle cruisers building for the United States have been redesigned with greater protection. There yet remains a question whether they are fit to lie in the line.

The Sea Habit

"CATCH them young, dip them in tar, and they never know the difference." Such was said by an admiral of the old school to be the method of recruiting the officers of the British navy. Story and song tell of the midshipmite, and finally a grave question was asked in Parliament whether the securing of the British Empire depended on sending children to sea. They still catch them young, but they send them to school; whether they will continue the old breed of sea dogs remains to be seen.

Our own method takes young men of sixteen to eighteen—about the college age—and keeps them at the Academy for four years. Truly, they have summer cruises, but the sea habit must be attained after they are old enough to vote, and the sea habit is not for everyone to attain. The reputation of the officers of the American navy needs no defence, and a method which has stood the test of time is not lightly to be criticised; but the best method that can be devised is none too good for a navy such as ours is and is going to be. Cannot some method be devised by which the sea habit may be attained young?

Determination of Brake Horsepower

WITH the advent of the steam turbine and the internal combustion engine, means for measuring shaft or brake horsepower became imperative. The stationary steam turbine has been most widely used at electric power stations and the output of the electric generator and its efficiency gave a ready way of determining the input; the input is appreciably equal to the turbine shaft horsepower. For other purposes the turbine power can be inferred from similar turbines which drive electric generators. On shipboard various forms of shaft dynamometers have been applied, which serve their purpose, though none is entirely satisfactory.

Small steam engines and other motors have had friction brakes applied to determine the shaft horsepower and the mechanical efficiency. Commonly such brakes have been improvised or, at any rate, cheapness has dominated the construction. Up to ten horsepower any decent rig will work after a fashion and the brake may run without cooling water, at least for short periods. But when large powers are to be absorbed the brake must be well designed, soundly built and must have an efficient water cooling system. Such a brake is likely to be bulky and costly, but may be made to run steadily under full load for any length of time and will give accurate and reliable results. The Alden brake of special construction has been made to absorb several hundred horsepower.

If any motor can be adapted to driving an electric generator, its brake or shaft horsepower can readily be inferred from electrical measurements of the generator. But this requires certain standardization of the motor and usually demands the attention of an electrical engineer. Electrical engineers commonly use a cradle dynamometer, made by hanging a generator on an axis and preventing its motion by a brake arm and weights. Such a device is an electric brake, and power is computed as for a friction brake from the length of arm, load on the arm and the number of revolutions. Large cradle dynamometers are expensive and inconvenient in use.

The Froude hydraulic dynamometer described in another column of this magazine appears to fill all the requirements for the ready determination of shaft horsepower and is now made in all sizes up to 6,000 horsepower. It is compact and powerful and is not unduly expensive.

The Naval Engineer

ANY military organization is essentially aristocratic, and aristocracy is naturally snobbish, and snobbery never accomplished anything except making somebody unhappy and interfering with his usefulness.

Our navy was fortunate in that the first engineer commissioned was a gentleman with acknowledged character and reputation. He was the equal of any line officer and would accept a commission on no other terms. He did more unconsciously for the morale of our navy than all his recorded work. Nevertheless, relative rank was so unsatisfactory that the staff was amalgamated with the line, and some people think we then lost our engineers from the navy.

The epitome of aristocracy was found in the German army and navy; every officer had to present evidence of nobility before receiving his commission. It is not certain whether engineers in the navy conformed to this condition. However that may be, the deplorable condition of the German ships when surrendered has been charged in part to the fact that the engineers were socially an inferior caste.

The British navy about fifteen years ago undertook to deal with the friction between the deck officers and the engineer officers by drawing them from the same source and holding the chance open for young officers to pass from one corps to the other. Now after trial of this system they have decided that an engineer is different from a sailor and the chance is closed. The acknowledged difficulty is that the prize of high rank and command is not open to the engineer. A partial solution is to establish a number of positions for shore duty carrying the rank of admiral. They keep the priceless advantage of drawing all officers from the same source and, in part, of training them together.

This action of a navy that has just passed through the bitter experience of the great war should be considered by our naval authorities. The first line of defense of the honor and security of our nation rests and will rest with the navy. No snobbery that one duty is nobler than another should stand in the way of making our naval personnel the best.

LETTERS TO THE EDITOR

Attitude of Sea-Going Engineers

The public press has carried statements to the effect that the marine engineers employed on ocean steamers, through their representatives, have refused further negotiations with the representatives of the steamship owners of the Atlantic Coast.

To correct any misapprehension which might be in the minds of your readers regarding this matter, we beg to state that the marine engineers employed on sea-going vessels, through their organization, and in good faith, entered into an agreement with the various shipowners and the United States Shipping Board, said agreement covering the conditions of employment, wages paid, subsistence while in port and the hours of labor.

This compact was specifically stated to terminate on the first of May, 1921, the expectation being that on that date some superseding agreement would have been entered into and put in force.

The steamship owners, about the middle of January, requested the marine engineers to agree to a reduction in wages equivalent to 25 percent, an immediate elimination of overtime and several other important concessions.

The owners' representatives were informed that this proposition would be taken up and considered by the marine engineers' organization, a decision speedily reached and the owners notified of the decision.

We wish now to state to the owners and to the public that at all times the marine engineers are willing, through their representatives, to discuss any matter, or enter into negotiations having for their object the betterment of the American merchant marine.

New York. Bert L. Todd, Secretary.
Marine Engineers' Beneficial Association No. 80.

The Economical Cargo Ship

In the December number of this magazine there is a most important article by Mr. Alfred J. C. Robertson on the "Economical Cargo Ship," intended to enable a ship designer to so select the form and proportions as to secure the best results. Contrary to an idea formerly prevalent, the form and proportions of cargo ships have an important influence on the powers required to drive them, especially if relatively high speeds such as ten to twelve knots are desired; and changes of form that may at first seem unimportant are likely to have appreciable effect on power. This comes from the fact that cargo ships must have a large carrying capacity, which is best secured by having a considerable parallel body; the entrance and run must be faired to avoid undue resistance and to supply water to the propeller. The length of entrance and run are so reduced that wave interference is liable to occur.

The writer of this paper has unconsciously overcondensed it. Being familiar from daily use with the elements in which he deals—the forms and factors—he does not appreciate that the uninitiated, though a good naval architect, may have much trouble in reading and applying the article. Examples are supplied to illustrate the use of the diagrams of the article, from which a naval architect may learn how to use the data given, if he is ingenious and pertinacious. Had the author taken half again the space (which the magazine would doubtless be glad to use) the usefulness of the article would be doubled. The diagrams also are too small for convenient use and are in some cases so compressed that they overlap.

It is a secondary matter, but the use of Tideman's friction factors is to be deprecated. As has several times been pointed out, he made no experiments on friction but derived his tables from Froude's data. There is good reason to believe that Froude's values are too high, and the use of Tideman's values merely means that the naval architect is hedging to the amount of 5 percent. Now it is all right for the naval architect to hedge, but he should do so openly and should at least write down his margin in his own notes.

Washington, D. C. C. H. Peabody, Dr. Eng.

I appreciate the kindly criticism by Professor C. H. Peabody of my paper entitled "Economical Cargo Ships—Some Model Experiments" read last November before the Society of Naval Architects and Marine Engineers, and excellently reproduced in your December issue. I regret that it was presented in such a form as to make it difficult of application to the everyday needs of the naval architect.

It is true that the paper was very much condensed, but that was at the request of the society, whose finances last year were rather overburdened by the cost of printing the transactions. This also applied to the diagrams, which could have been much extended and enlarged. For example, the experiments were all conducted at four drafts, and the writer would gladly have included the effect of draft upon the C constant value, but as this was fully dealt with by Mr. Kent eighteen months ago, that part of the paper was sacrificed to the exigencies of space.

I agree wholly with your correspondent that the standard frictional coefficients of Froude should be used, but these would have been misleading to tank students in this country, who have only had tank tests of ships by the Tideman coefficients available to them. I have provided correction curves, Plate 4, which make the results contained in my paper available for comparison with results by Froude's coefficients.

With all the faults of presentation, however, I would take the liberty of suggesting that the information contained in the paper is well worth ingenious and pertinacious study by designers of full cargo ships.

New York. A. J. C. Robertson.

Comparison of Electric with Geared Turbine Drive in Merchant Vessels

Mr. Emmet's article on the above subject in your January issue does not seem to be quite fair to the geared turbine in the matter of comparative efficiency. The figures for electric drive are given as 92.5 percent for small powers and 95 percent for large powers, while gears are only credited with 93.5 percent for double reduction and 96 percent for single reduction.

Without wishing to dispute Mr. Emmet's figures for the efficiencies of electric transmissions, it must be said that they appear to be very high, and it would be interesting if he can give some additional information regarding the actual efficiencies of generators and motors, including excitation and the horsepower on which they are based. The mechanical efficiency of reduction gears depends to a great extent on the design and workmanship. The losses in the bearings are generally greater than in the gears, so that the net result depends largely on the number and dimensions of the bearings and on the conditions of lubrication. It is reasonable to assume that Mr. Emmet's figures for gear efficiencies have been obtained from tests of single and double reduction gears for marine propulsion as designed and built by the General Electric Company. The most widely distributed type made by that company for the propulsion of cargo vessels is known as the one-plane type, involving the use of three pinions and three gears with twelve or more bearings. This type of unit necessarily spreads over a large area of foundation which has to be supported on a structural frame work which is subject to considerable strain and distortion from the effects of wind and sea. In such circumstances the alinement of the different gear and pinion shafts may be difficult to maintain and a loss of efficiency must be expected. The figure of 93.5 percent is

probably based on a shop test, where the gears would be mounted on a rigid floor plate; hence it is quite reasonable to assume that the results under seagoing conditions would be no better, if as good.

A very large number of double reduction gears for cargo boats have been built by The Falk Company, of Milwaukee, Wis., and used with compound Parsons turbines. The fundamental idea which is expressed in the design of these gears is to avoid distortion by supporting the shafts in three planes in a very rigid frame standing on a relatively small and almost square base. Tests for rigidity have shown that it is practically impossible to throw the different bearings in one of these units out of line with each other, and there is no likelihood that mechanical efficiencies obtained in a shop test will differ materially from the net results which may be anticipated when the gears are operating in ships.

High Efficiency Shown in Tests

An actual test was made in June, 1920, on two of these units, rated at 3,100 shaft horsepower, reducing from 3,200 to 90 revolutions per minute. The test was very carefully conducted by running the two units in opposition to each other, while the equivalent of the power lost in friction was furnished by a motor, and the losses were measured electrically. On a long endurance run covering several hours the net overall mechanical efficiency of each gear unit averaged from 97.35 percent to 97.45 percent, showing a loss of about 2½ percent as compared with Mr. Emmet's 6½ percent.

A similar test was made in August, 1919, on two 6,000-horsepower single reduction gear units for compound turbines, 1,800 to 125 revolutions per minute. The net efficiency obtained on this test was 98.1 percent.

At a somewhat later date The Falk Company had occasion to build some more 6,000-horsepower single reduction units and a test of these was made in October, 1920. The later units were furnished with gears and pinions of larger diameter and greater face width than the corresponding gears in the earlier units. The pinion bearings in the later units were designed differently as the result of experience gained in the meantime. As a result the average efficiency from a 24-hour run, 98.32 percent, showed a marked improvement over the earlier test, notwithstanding the increase in gear dimensions. This figure of 98.3 percent compares very favorably with the 96 percent credited by Mr. Emmet to this type of gearing.

Causes of Failures

With regard to the portion of the article which deals with the possible causes of failures in marine reduction gears, the idea that this may have been due to distortions of the gear casings and consequent misalinement of gear teeth and bearings seems reasonable enough when considered in connection with the type of gear in which failures of this kind have been most conspicuous.

The tendency towards increased gear dimensions may be explained as being the outcome of a desire to play safe after unfortunate experiences with gears which were either too small for the work they were required to do or were designed with too little regard for the difference between conditions on board ship and on land. The correct proportions for rigid gears were sufficiently well known before there was any marked activity in this country in this particular line of endeavor. The Falk Company is using the same general dimensions now as then.

Under the circumstances it is interesting to note on page 31 of the advertising section in the same issue that contains Mr. Emmet's article that the original low speed gear on the S. S. *Pacific* is still in service after 230,000 miles of travel. The low speed gears for S. S. *Pacific* were furnished by The Falk Company.

The Falk Company, Milwaukee, Wis. — Percy C. Day.

NEW BOOKS

Marine Engineers' Handbook

REVIEWED BY C. H. PEABODY, DR. ENG.

Marine Engineers' Handbook. By Lieutenant-Commander Frank Ward Sterling, U.S.N., Editor-in-Chief. Size, 4⅝ by 7⅛ inches. Pages, 1,486. Numerous figures, diagrams and tables. New York, 1920: McGraw-Hill Book Company.

This important work full of information was prepared by a staff of thirty specialists, each an expert in his own field. The editor-in-chief claims that it is a pioneer in its field, that the trail has not always been plain to read, and that this edition aims at a general survey of the new territory. This claim is not invalidated by the existence of an excellent handbook belonging to the period of the reciprocating engine, a type yet important, though its treatment in this book is compressed into 120 pages.

Of the staff three are professors, twelve are engineers, eight are administrative officers, three are experts and four are naval officers, though it might be proper to class all as engineers and experts. With all team work possible, the existence of so large a staff, each responsible for his own work, leads at once to congestion and over condensation. Some sections full of important information appear to be too extensive, such as those on metallurgy, special welding and steam turbines. Others are brief, as the powering of ships, heating and ventilation, electrical installations and refrigerating machinery. Others are frankly descriptive, like the sections on deck machinery and engine room auxiliaries.

The mathematical introduction deemed necessary for every engineering handbook is judiciously condensed. It is followed by a section on mechanics that cannot be so much commended, for example, the definition of momentum as the quantity of motion does not appear to have significance.

The section on metallurgy is excellent, compressing into small space information of the greatest importance to engineers on various alloys and iron and steel, together with a statement of heat treatment and of welding by the oxy-acetylene torch and by the use of thermit. Curiously, electric welding is not mentioned. One is led to wish that the writers might write a book for engineers and thus avoid the necessity for drastic condensation. The vast variety of modern "steels" is indicated by the list of metals used to make what are really iron alloys, namely, nickel, chromium, vanadium, molybdenum, tungsten, zinconium and titanium; all these besides carbon, silicon, sulphur and phosphorus which are likely to appear purposely, accidentally or as impurities.

The section on heat admirably assembles the data required by an engineer concerning heat and its effects on materials used in engineering, but why should the working engineer be troubled by general thermodynamic equations or a discussion on the real significance of entropy? The properties of steam are taken from a well-known and approved collection of tables, as good as any one of half a dozen authoritative tables now extant. All these collections are based on the same fundamental data, are correctly computed and give closely concordant results; any one may be taken as standard, but none is.

The section on fuels and combustion (coals, oils and gasoline) is brief and good, as is the description of apparatus for burning oils and the precautions for storing and using. The descriptions and explanations of instruments for determining viscosity, flash point, etc., are more detailed than needed, unless engineers are expected to make their own determinations. They doubtless could become experts, but should they?

The discussion of marine boilers by a well-known engineer of wide experience is well arranged and, on the whole, judicious. When space is so valuable as in a book of this sort

one begrudges even four pages on ancient history and the space given to detailed boiler tests. The space assigned to the Babcock and Wilcox boiler may be justified by the importance of this excellent type.

Nearly three hundred pages are given to the steam turbine; this is both too little and too much. It is too little for a turbine designer and too much for anybody else. A turbine designer needs a small library of books and a Molier's diagram as big as a table if he uses that method; even then it is a question whether he can properly compute reheat of the steam. There remains a question whether it is ever worth while. A large space is given to general illustration. The superficial description of the electric drive is as much as should be given to what is the electrical engineer's job. Hydraulic reduction gear does not deserve mention. It is notable that marine steam turbines tend to reduce to two types, the reaction or Parsons turbine, and the pressure compound turbine with an introductory velocity compound stage. Also by the use of some form of reduction gear, mechanical or electrical, the turbine tends to approach the stationary type and can be contracted for as a unit, so that the marine engineer is relieved from knowing too much of details.

The reciprocating engine has been obsolescent ever since Parsons put his turbine in the *Turbinia,* and is likely to remain obsolescent for a long time; it is unfortunate that the consideration of this old, reliable motor has been overcondensed. Selecting a small but important detail, the method of making a preliminary layout of cylinders and crankshaft on page 918 is excellent. On the other hand, the method of balancing, both by computations and graphically, is overcondensed to be useful. There are tables extant of acceleration for various crank and connecting rod ratios; if they are inaccessible for a handbook on account of copyrights they may be readily recomputed. Every proper handbook on reciprocating engines should have them as regularly as tables of properties of steam.

The information proper for a real discussion of the Diesel engine is in the hands of the makers; some day there will be a real handbook for internal combustion engines, but that day is not yet. The treatment of condensers and their auxiliaries, air pumps, condensate pumps, circulating pumps and vacuum augmenters is descriptive and good as far as it goes.

The very important matter of screw propellers by Admiral C. W. Dyson is presented in the form developed by himself during a period of years and used by himself, the staff of the Bureau of Steam Engineering and by some engineers in private yards. This method, which is credited with giving excellent results in practice, has been much under discussion and has been successively revised by its author to adapt it to the various conditions that have arisen. Anyone who wishes to master this peculiar method will find the discussion here presented an introduction to the author's "Screw Propellers for Hydraulic and Aerial Propulsion." In the development of his method the author has made his own terms and determined the methods of using them. When he uses customary terms he redefines them at will, sometimes giving quite a different significance, as, for example, his definition of thrust deduction, which is unlike Froude's term, having the same name. Noting a small but not unimportant item, the relative powers of two-, three- and four-bladed propellers are expressed by three constant factors given to four significant figures. Now experiments on model propellers, which cannot be gainsaid, show that the relations are not constant and they are not known to such a degree of precision. This treatment may be compared with that by Mr. Barnaby in a book reviewed in this magazine, a simple method used by him with success in designing the numberless propellers for Thornycroft and propellers for other builders.

Even in a book of fourteen hundred pages the pressure for space has made it necessary to compress the discussion of subjects like piping plans, deck machinery, evaporators, ventilators and ejectors, etc., etc. In much, if not in most, the editor's claim that the book is a pioneer is justified, and we may congratulate him and ourselves that we have so much as he and his staff have been able to give.

Marine Propellers

REVIEWED BY C. H. PEABODY, DR. ENG.

Marine Propellers. By Sidney W. Barnaby. Size, 6 by 8 inches. Pages, 230. Illustrations, 56. Tables, 13. New York, 1920: Spon & Chamberlain; London, E. & F. N. Spon.

This is the sixth edition of a well-known and highly valued book. The first edition was issued about thirty years ago; the author gave the first logical process for designing propellers based on experiments by the Froudes on model propellers. This work was presented in the form of a table by aid of which problems could be solved rapidly and certainly. Since that time the table has from time to time been improved and extended, this latest edition giving the greatest extension of pitch ratio and slip as yet proposed. Mr. Barnaby is the scientific expert for Thornycroft, and has designed not only all the numberless propellers for that company, but also propellers made or designed for other builders. This experience confirms the reliability of the method of designing propellers from the data obtained from experiments on models. This conclusion applies not only to Mr. Barnaby's method, but to the method of Admiral D. W. Taylor of the United States Navy.

Since the book is so well known, attention will be called only to new information or to characteristic features.

Next to the arrangement for convenient use of experimental data, Mr. Barnaby's most notable contribution to the profession was the identification of the phenomenon of cavitation and the prescription of methods for avoiding it. It still remains true that Mr. Barnaby's investigation of the phenomenon of cavitation on the *Daring* is unique. The only material addition to his report is the information that cavitation has not appeared in certain turbine steamers where his limits are exceeded. Mr. Barnaby concludes that the immunity is due to constant turning moment, and gives the caution that irregular turning moment experienced with some internal combustion engines is liable to lead to cavitation before his limit is reached. After long experience he confirms his opinion of the cause and remedy for cavitation. In particular he does not think that tip speed of the propeller has a determining influence. In this edition he gives tables showing speeds at which cavitation may be apprehended, computed both on 11¼ pounds thrust per square inch and on 13 pounds. The former is recommended for reciprocating steam engines and the latter for turbines.

A feature which was found in the previous edition deserves mention now, namely, the discussion of the influence of depth on speed based on tests in the model basin by Colonel Rota. This discussion shows what depth of water is most favorable for any ship of the destroyer type, and is useful both ways.

The British, having begun with paddle towboats and finding that they have certain conveniences, keep on with them, although in early times the advantages of the propeller were shown by the trials of the *Rattler* and the *Alecto.* This matter was tried again in 1913 when Thornycroft made competitive trials of paddle and screw towboats, demonstrating again that the screw could pull the hardest.

It is characteristic of aeronautical engineers that they not only use a different method for designing air propellers from that used by marine engineers, but that they tend to disqualify the information of that class of engineers and even seem to fear contamination of their science by contact with their methods. It is, therefore, the more interesting to know that Mr. Barnaby finds he can use his propeller table for designing screws for an airplane and obtain fair concordance with the aeronautical engineers' results.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

CONDUCTED BY JAMES L. BATES

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

Oil Fuel Atomizers

Q. (1113).—Will you please publish the method of calculating the design of an oil fuel sprayer, viz.: 900-pound oil fuel sprayer and how to obtain the number of sprayers required for a given boiler. L. T.

A. (1113).—The development of the atomizers at present in use has been largely the result of careful experiment. It is perhaps possible to derive laws based upon the information experimentally obtained, which would be of value in the design of oil burning apparatus, but it is understood that little has as yet been done in this direction.

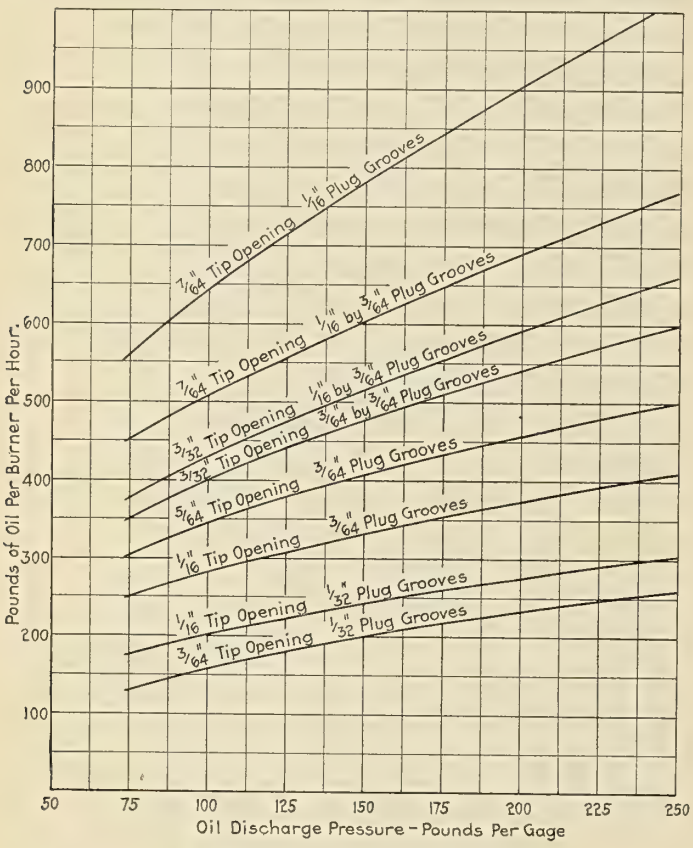


Fig. 1.—Pressure Capacity Curves

Fig. 1 shows pressure capacity curves which represent the results of the experimental work carried out by the Bureau of Engineering, Navy Department, with its Type 1 standard pressure atomizer. The three upper curves are based upon tests with Gulf Refining Company oil, specific gravity .8827 at 60 degrees F., viscosity 3.35 Engler or 115 Saybolt, temperature of oil 85 degrees F. The five lower curves are based upon tests with Texas oil, specific gravity .9115, temperature 90 degrees F., viscosity 7.02 Engler or 260 Saybolt.

Setting Blades of Sectional Propellers on Lake Steamers

Q. (1119).—One subject on which I am looking for information is propellers; more especially on the different methods of setting the propeller blades of a sectional wheel. We use many sectional wheels on lake vessels and also break them quite frequently. Oftentimes we have to put them on at night. The most common method employed at night, or at any other time, in setting the blades is to use a pitch board and sight from the pitch board to a straight edge held across the end hub. At night it is simply a case of guess. I have often thought that there must be other methods of doing this job that would be a whole lot more satisfactory. Oftentimes we have to put on blades under difficulties. Sometimes in the spring, when blades are broken working in ice, it is a case of pump the water ballast out so as to get the wheel above water, or rather the hub, and get down on the ice and replace the blades. In the running season they get broken in port, as we are usually drawing all the water in the harbor. D. N. H.

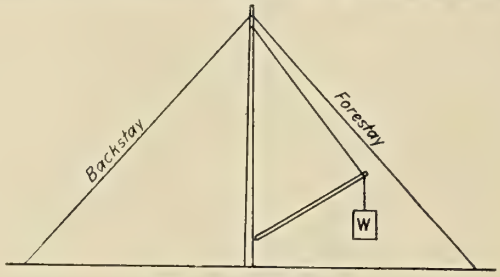
A. (1119).—For work under the difficulties which you describe it would probably be impractical to secure results of great accuracy. It may be that reference to pages 606, 607, 608 and 609, seventh edition of "Practical Marine Engineering," by Admiral Dyson, would throw such light on the principles underlying the whole subject as would assist you in making improvements in present methods.

Stresses in Rigging of Mast

Q. (1122).—Please solve the following problem: Suppose a mast, as shown in the sketch, to carry a certain weight on the boom; the stress on the mast and on the backstay can easily be determined. With the boom as shown, the mast would need no other support (theoretically). However, it is desired to rig a forestay. How is the stress in the forestay calculated so that the backstay will remain taut when the boom is unshipped?

What is the best book on strength of rigging and masts? A. L. D.

A. (1122).—From the wording of your question it is assumed that you desire to rig a forestay in such a manner that the backstay will remain taut under the tension of either the forestay or the boom topping lift acting singly. It is also assumed that a single backstay is fitted in the fore and aft line of the boom and forestay.



Sketch of Rigging

Now it is evident that a given tautness (tension) in the backstay can be maintained independently by either the forestay or the boom topping lift only when the horizontal components of each of these separate tensions are equal. Since the boom topping lift must necessarily make a more acute angle with the mast than does the forestay, in order that the boom end may have proper clearance, a greater tension will be required in the topping lift than in the forestay, if their horizontal components are to equal each other. This requirement presents no difficulty in itself for the reason that for the usual weight of boom and the load to be handled the tension in the topping lift will exceed that calculated for the forestay under the forces due to the weight of mast and all fittings, wind, angular acceleration due to pitching and weight of and tension in aerials, etc.

Since the forces previously enumerated may act on the

mast at the same time the weight is being hoisted by the boom, the backstay must therefore have sufficient strength to withstand the combined tensions of the boom topping lift and the forestay. Whether we assume that a given tension in the backstay is exactly balanced by either the tension in the topping lift or that in the forestay acting independently or the two acting simultaneously, it is obvious that equilibrium could be maintained only when the boom is in the fore and aft position shown in the sketch and sustains a constant static load, even were the tension in the forestay constant, which is not the case. It is readily seen that the topping lift tension will always be a variable quantity, for the instant the boom swings out of the fore and aft position the topping lift tension acts obliquely to the backstay, thereby reducing the tension in the backstay and inducing a tension in the shrouds on the opposite side from the boom. Hoisting or lowering the weight also changes the load on the boom on account of acceleration, while the removal of the load or the unshipping of the boom altogether practically or completely eliminates the topping lift tension.

In view of these considerations the impracticability of maintaining a constant tension in the backstay is apparent. Theoretically, at least, if an initial tension is set up in both the forestay and the backstay such that their horizontal components are equal and of such intensity as will equal or exceed the sum of the horizontal components of the maximum separate tensions in both the topping lift and the forestay, as calculated for the forces acting on each, then the tension in both the forestay and the backstay will remain unchanged whether the boom is in position and is being operated or is unshipped. This will result in fitting a much larger forestay than would otherwise be required. Such a design will usually be impracticable where heavy weights are to be handled, owing to the high initial tension required and the difficulty of securing it under the conditions of actual service.

In actual practice no attempt is made to maintain a constant tension in the backstay. Assuming that shrouds are fitted, their lower ends would necessarily have a drift aft in order to permit the boom to swing athwartship. In whatever position we assume the boom to be placed, the tension in the backstay will be affected by the action of the shrouds. This effect will vary with the position of the boom, and in practice is indeterminate because of the number of factors involved.

In cases like that shown it is customary to proportion the backstay so as to take the stress induced by the loaded boom, the mast being considered as hinged at the deck and the action of the shrouds ignored. This is done in order to simplify the calculations and eliminate, so far as may be, the allowance for bending in the design of the mast itself. (Of course, were no forestay or other similar supports fitted, the mast would have to be designed to be self-sustaining except when the boom is in use.) An allowance is made for initial tension or "set up" in standing rigging, the mast as before being considered as hinged at the deck, but no allowance for the effect of boom with its weight.

I am unable to recommend any one book which satisfactorily covers strength of rigging and masts. The recognized classification societies have rules and tabulations covering the size and type of the masts, spars and rigging for sailing and steam vessels. The "Shipbuilding Cyclopedia," published by Simmons-Boardman Publishing Company, New York, contains excellent type plans of masts, spars, rigging and detail fittings as blocks, smith work, etc. "Machine Design, Hoists, Derricks, Cranes," by H. D. Hess, gives valuable data on fiber stresses in timber; action of wire rope, stresses in same, etc., when handled over drums and sheaves; a discussion of graphics; blocks and block efficiencies, etc.; derricks and derrick fittings, with analyses of stresses and numerical examples.

Geared Turbines Versus Reciprocating Engines

Q. (1123).—Can you supply data showing a comparison of results from vessels fitted with geared turbines and with reciprocating engines? How do they compare as to fuel consumption, repairs, payroll, speed, power, etc.?

A. (1123).—The following data taken from the 1920 December issue of *The Shipbuilder* is an interesting comparison of "running costs" of motorships and steamships:

	1,000 Brake Horsepower Engines					2,400 Brake Horsepower Engines				
	Single screw, Diesel 1,000 B.H.P.	Single-screw, Double-reduction Geared, 1,000 S.H.P.		Single-screw, Reciprocating, 1,200 I.H.P.		Twin-screw, Diesel 2,400 B.H.P.	Single-screw, Double-reduction Geared, 2,400 S.H.P.		Single-screw, Reciprocating, 2,800 I.H.P.	
		Coal	Oil	Coal	Oil		Coal	Oil	Coal	Oil
Fuel, lb. per H.P. per hr.	.45	1.5	1.1	1.95	1.4	.45	1.5	1.1	1.75	1.25
Consumption, tons per day	4.82	16.1	11.8	25	18	11.6	38.6	28.3	52.5	37.5
Consumption, tons per 30 days	145	483	354	750	540	348	1,158	849	1,575	1,125
Price of fuel per ton	£11	£5	£10	£5	£10	£11	£5	£10	£5	£10
Cost of fuel per 30 days	£1,595	£2,415	£3,540	£3,750	£5,400	£3,828	£5,790	£8,490	£7,875	£11,250
Lubricating oil consumption, gallons per day	10	2	2	3	3	21	3	3	5	5
Lubricating oil, cost per gallon of	5/-	5/-	5/-	5/-	5/-	5/-	5/-	5/-	5/-	5/-
Lubricating oil, cost per 30 days	£75	£15	£15	£22 10s.	£22 10s.	£157 10s.	£22 10s.	£22 10s.	£37 10s.	£37 10s.
Personnel—										
Chief Engineer	1	1	1	1	1	1	1	1	1	1
Assistant engineers	3	2	2	2	2	6	3	3	3	3
Greasers	3	3	3	3	3	3	3	3	3	3
Firemen	—	3	3	3	3	—	9	6	9	6
Trimmers	—	3	—	3	—	—	4	—	4	—
Donkeyman	1	1	1	1	1	1	1	1	1	1
Electrician	1	—	—	—	—	1	—	—	—	—
Total engine-room staff	9	13	10	13	10	12	21	14	21	14
Total wages, 30 days	£191	£224 10s.	£195	£224 10s.	£195	£252 10s.	£380 10s.	£265	£380 10s.	£265
Total upkeep per 30 days, at 7s. per day	£94 10s.	£136 10s.	£105	£136 10s.	£105	£126	£220 10s.	£147	£220 10s.	£147
Total wages, fuel, oil and upkeep for 30 days	£1,955 10s.	£2,791	£3,855	£4,135 10s.	£5,722 10s.	£4,364	£6,413 10s.	£8,924 10s.	£8,513 10s.	£11,699 10s.
Ratio	1	1.44	1.97	2.12	2.93	1	1.47	2.04	1.95	2.68
Net saving per annum of 200 days sailing, Diesel over steam	—	£5,570	£12,650	£14,520	£25,250	—	£13,650	£30,390	£27,645	£48,850

No account is taken in this comparison of the savings effected for motorships in fuelling costs, less demurrage, additional cargo capacity, less accommodation for engine-room staff, no standby losses, less cleaning ship, higher average speed in a seaway, and reduced fuelling appliances required. On the other hand, the first cost of Diesel engines, Mr. Richardson states, is at present from 25 to 33 percent more than for steam plant. The economy of operation possible with the oil engine, however, is such that, granted reliable performance, the extra first cost is speedily balanced by the increased profits available.

PERSONAL MENTION

John Hunter, the well-known power plant engineer, has just accepted the position of chief engineer of the Heine Safety Boiler Company, St. Louis, Mo.

Clarence Samuel King, for the past three years manager of the Philadelphia office and secretary-treasurer of the Delaware River section of the Atlantic Coast Shipbuilders' Association, has been elected secretary of the association succeeding Henry C. Hunter, of New York, who has been appointed counsel. In assuming his new duties, Mr. King announces the removal of the association's general offices from New York to 1701 Walnut street, Philadelphia. Mr. King will continue as secretary of the Atlantic Coast Shipbuilding Industrial Board which was established at the close of the world war by agreement with shipyard owners and international labor unions to adjust all questions pertaining to rates of labor, hours of work and conditions of employment in the signatory shipyards.

H. McL. Harding, consulting engineer, Harbor Commission, Milwaukee, Wis., gave an illustrated lecture on Docks, Quays and Piers at the thirty-seventh annual meeting of the Connecticut Society of Civil Engineers, held in New Haven, Conn., on February 15 and 16. Mr. Harding has been and is consulting engineer on many harbor developments. He is now preparing plans for improving New Haven harbor to make it a port of entry for vessels of deep draft.

G. L. Buchanan has been appointed by the Board of Managers of the American Marine Insurance Syndicates as the agent for Syndicate "A" in Cuba. Mr. Buchanan is a native American citizen; he is resident surveyor at Havana for the American Bureau of Shipping, which has consented to permit the Syndicates to utilize his services, both as surveyor and as agent, to represent the underwriters' interests in the care of wrecked and damaged vessels. This appointment will at once place at the disposal of the owners and underwriters the service of an expert, trained in the duties of the surveyor, who because of his detached position as the exclusive representative of the great American classification society and of the Underwriters Salvage Association, will be in an excellent position fully to protect the interests of both owner and underwriter of any American ship in trouble. Additional interest is attached to the appointment as it marks the first step in the development of the Syndicates' foreign policy of utilizing the services of our own nationals wherever adequate and available and, furthermore, is an evidence of the co-operative effort of classification society and salvage association to further the interests of the merchant marine.

Joseph W. Powell, vice-president of the Bethlehem Shipbuilding Corporation, has recently been appointed president of the Council of American Shipbuilders. Mr. Powell is a graduate of the United States Naval Academy, where he not only excelled as a student but is also well remembered as an idol of the football team. After graduation he served four years as a naval officer and was detailed on the cruiser *New York* during the Spanish war. It was at the harbor of Santiago that Cadet Powell experienced the first great adventure of his life when he assisted Lieutenant Hobson in sinking the *Merrimac* for the purpose of bottling up the Spanish fleet. His own story of this daring feat is best told in his own words given at the time:

"About 2:30 P. M. I took the men, who were not going into the narrow mouth of the harbor, in the launch from the *Merrimac* and started for the *Texas*. I had to go back for Assistant-Engineer Crank, who had refused to leave the *Merrimac* to the last. I shook hands with Hobson the last of all. He said: 'Powell, watch the boat's crew when we pull out of the harbor. We will be cracks, rowing thirty strokes to the minute.'

"After leaving the *Texas* again I saw the *Merrimac* steaming slowly in. It was only fairly dark then and the shore was quite visible. We followed the *Merrimac* in, about three-quarters of a mile astern. When Hobson was about two hundred yards from the harbor the first Spanish gun was fired from the eastern bluff. We were then half a mile off shore in our launch, close under the Spanish batteries. The firing increased rapidly. We steamed in slowly, but lost sight of the *Merrimac* in the smoke. We ran in still closer to the shore so that the gunners on the heights lost sight of us. Then we heard the explosion of a torpedo on the *Merrimac*, but could not see her. Until daylight we waited outside the breakers half a mile to the westward of Morro. About 5:00 A. M. we crossed the mouth of the harbor again. In passing we saw one spar of the *Merrimac* sticking out of the water. We continued to hug the shore just outside of the breakers and then turned out to sea towards the *Texas* when the batteries saw us and opened fire upon us. It was then broad daylight. The first shot fired dropped thirty yards astern, but the other shots went wild. I drove the launch for all she was worth, finally making the *New York* in safety. The men behaved splendidly."

As a result of this service Congress promoted Mr. Powell to the rank of ensign and the Government sent him to Glasgow, where he studied shipbuilding and marine engineering for three years. After returning to America he was detailed by the Navy Department to the Cramps Shipyard at Philadelphia, where he supervised the construction of several of our warships. He then accepted the position of assistant to the president of the Cramps Company, where his work attracted the attention of Mr. C. M. Schwab, who gave him the position of president of the Fore River Shipbuilding Company.

During the war Mr. Powell's organization built a model destroyer building shipyard at Squantum, Mass., and two other plants. He secured the largest naval contract on record, totalling $130,000,000 and involving the construction of seventy-one ships. The story of this big contract is one of the most romantic incidents of the industry. Mr. Powell later became operating head of the entire Bethlehem Shipbuilding Corporation, Ltd., and today he is considered one of the foremost leaders in the shipbuilding industry, who commands the respect and confidence of all concerned in ship construction. Mr. Powell has also recently delivered several very constructive addresses before various societies and conventions in regard to our future shipping and shipbuilding policies. He has advocated the enforcement of the Merchant Marine Act of 1920, particularly the clause relating to discriminatory duties, an able and efficient Shipping Board, the repeal of the Panama Canal tolls on American vessels and a Cabinet position for the chairman of the Shipping Board. We wish him the same success in the future as he has had in the past, not only for himself but for the good of the American merchant marine.

William M. Kennedy, general works superintendent of the Chester (Pa.) yard of the Merchant Shipbuilding Corporation, has resigned to accept a position with the repair department of the United States Shipping Board. Mr. Kennedy has been engaged in shipbuilding in its various branches for twenty years. His first work was as an apprentice with the Maryland Steel Company, Sparrows Point, Md. He served from 1908 to 1915 in various navy yards as a draftsman, mechanic, supervisor of new construction, estimator and in charge of estimating and planning. He was associated with Commander R. D. Gatewood, director of construction and repair for the United States Shipping Board, when the latter was in charge of work at the Panama Canal. While at the Panama Canal, Mr. Kennedy played a prominent part in the installation of the planning and production system used in the canal dry docks and shops. After completion of this work he became associated with the Merchant Shipbuilding Corporation at their Harriman yard, holding the position of assistant production manager. He was later made assistant works manager and then assistant to the general manager. On April 1, 1920, he was transferred to the Chester yard of the company as works superintendent.

Shipbuilding and General Marine News

Contracts for New Ships — Shipyard Improvements — Engineering Projects—Improved Appliances—Personal Items

EXTENSIVE CONSTRUCTION WORK AND PORT IMPROVEMENT FOR THE STATE OF LOUISIANA

Development of Waterfront at New Orleans Expected to Make it One of World's Greatest Ocean Terminals

Exhaustion of old world markets, with the consequent development of new ones, and revived use of inland waterways transportation have been the chief factors in the recent extensive development of New Orleans as a two-way port. When the Atlantic seaboard became so badly congested during the latter period of the war, the Government began to divert tonnage. Delays in eastern ports were hampering progress of the Allied armies. Then it was that New Orleans and other Gulf ports obtained a share of the tonnage and New Orleans ascended rapidly in the matter of exports.

The war also played a big part in the revival of inland waterway transports. Economical and efficient transportation became a national necessity. Idle rivers once more floated towboats and barges, and in this way the strategic location of New Orleans forced water and rail tonnage down the Mississippi Valley to the Crescent City for export. For years the commercial organizations of New Orleans had worked to interest the Government in greater use of the waterways.

This resulted in the War Department going into the New Orleans-St. Louis barge line on a large scale, and insured the ultimate success of the enterprise. Along with it, other waterway projects were given attention. The Warrior River was included in the barge line, giving the Alabama coal and ore mines a cheap outlet. Permission was granted to begin work on the canal connecting Chicago with the Mississippi; interest was revived in the Great Lakes-St. Lawrence project, and Ohio began to see some hope for the lock and dam system so long desired for the Ohio River.

That New Orleans is due to make greater strides seems a certainty. When all of these projects have been completed the rivers will bear a large volume of commerce, all of it floating down to New Orleans. The 20 percent differential on waterway transportation now maintained by the Interstate Commerce Commission will be a great incentive for shippers to use the improved waterways.

All of this merely explains the fortunate position of the port of New Orleans. It is a common sight to see an ocean liner docked at a New Orleans pier with one set of cranes loading cargo from a rail-served wharf while another set transfers freight from the hold of a river barge. Yet this is but one phase of the economy of transportation which the southern outlet has to offer. It is planned to have the port under the management of one efficient and competent person whose work is to be supervised by the Dock Board.

Just at this time, the State of Louisiana is going forward with three large enterprises which will increase materially the efficiency of the port. They are:

1—Building of an industrial canal and inner harbor at a cost of $20,000,000.

2—Construction of a coal tipple at a cost of $750,000.

3—Planning a $10,000,000 bridge across the Mississippi.

Started primarily as a war measure to enable New Orleans to build ships, the industrial canal and inner harbor are now intended to serve another purpose. They will give private enterprise a chance to develop river front facilities in strict accordance with its needs.

The industrial canal extends from the Mississippi River to Lake Pontchartrain, a distance of six miles. When completed both sides of it will be available for factory and warehouse. The canal will have a depth of 30 feet and a width of 300 feet. The great lock at the Mississippi River end will accommodate a ship 74 feet wide, 700 feet long and having a draft of 30 feet. There will be 35 feet of water on the sill practically all the time. An industrial strip of land 1,000 feet in width on either side of the canal will be served by the Public Belt Railroad, in this way once more effecting an economical co-ordination of rail-river-ocean transportation. The project is being financed by the Dock Board, the New Orleans Levee Board and the Public Belt Railroad, all public enterprises.

Railway Steamer Launched

The steamer Melines, 337 feet long, has been launched at the Armstrong yard of Sir W. G. Armstrong, Whitworth & Company, Ltd., for the Great Eastern Railway Company.

ADVANCE LECTURE PROGRAM FOR OCEAN ENGINEERS

The program of lectures thus far arranged for Ocean Marine Engineers' Beneficial Association No. 80, 15 Whitehall street, New York City, is announced by the Education Department of the association as follows:

March 15—C. R. Waller, DeLaval Steam Turbine Company; subject, "Geared Marine Turbines."

March 29—George F. Bateman, assistant professor of Mechanical Engineering, Cooper Union; subject, "Reciprocating Steam Engines."

April 12—W. E. Thau, Westinghouse Electric & Manufacturing Company; subject, "Electric Propulsion of Ships."

April 26—H. B. Taylor, Chief Turbine Engineer, United States Shipping Board; subject, "Marine Propulsion."

May 10—R. H. Rogers, General Electric Company; subject, "Marine Electric Auxiliaries."

May 11—Jos. J. Nelis, manager marine department Power Specialty Company; subject, "Watertube Boilers and Superheaters."

Other dates will be arranged later for lectures by Mr. P. C. Day, manager of the gear department of the Falk Company, on "Gearing," and Ernest H. Peabody, of the Peabody Engineering Corporation, on "Fuel Oil Burning."

WORLD'S TONNAGE FIGURES

It was stated in the British Parliament that the tonnage of merchant ships of 100 tons and upward owned by foreign maritime nations in July, 1914, as compared with the figures in 1920, was as follows:

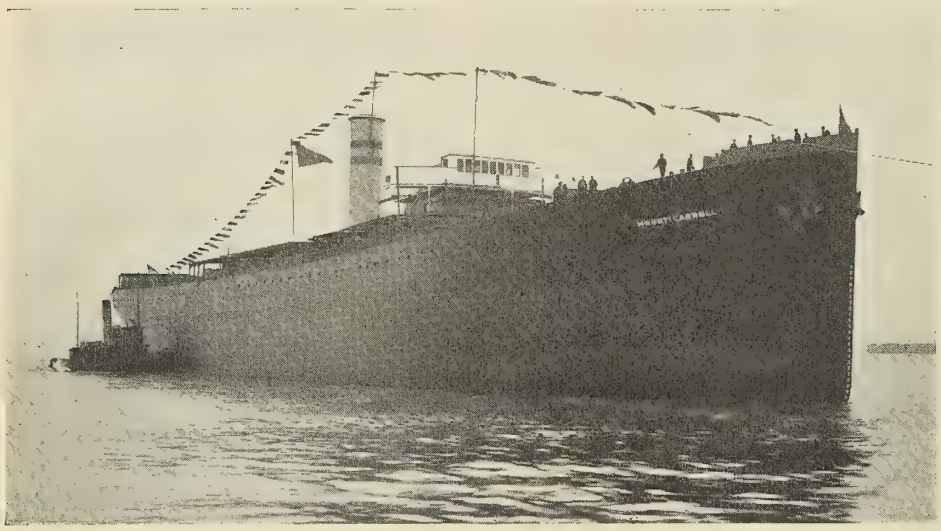
	July, 1914, Tons	July, 1920, Tons
United Kingdom (excluding British overseas possessions)	19,256,766	18,330,424
Total British Empire	21,045,049	20,582,652
Austria-Hungary	1,055,719	.....
Denmark	820,181	803,411
France	2,319,438	3,245,194
Germany	5,459,296	672,671
Italy	1,668,296	2,242,393
Greece	836,868	530,261
Japan (excluding sailing vessels)	1,708,386	2,995,878
Holland	1,496,455	1,793,396
Norway	2,564,722	2,219,388
Russia	1,053,616	534,547
Spain	896,823	997,630
Sweden	1,118,066	1,072,925

Mechanical Engineers' Convention

The spring meeting of the American Society of Mechanical Engineers will be held at the Congress Hotel, Chicago, Ill., May 23-26. Sessions are planned by the professional sections on aeronautics, fuel, machine shop, power, forest products and railways.

FIRST AMERICAN BUILT SHIPS FOR THIRD-CLASS PASSENGERS ARE LAUNCHED

"Mount Carroll" and "Mount Clinton" Give Distinctive Trans-Atlantic Service for United American Lines



Launching of the *Mount Carroll* of the United American Lines, the First American-Built Passenger Ship Intended for Exclusively Third-Class Passenger Traffic

At the Chester (Pa.) yard of the Merchant Shipbuilding Corporation on February 8, the steamship *Mount Clinton* was successfully launched. A sister ship, the *Mount Carroll,* was launched from this same yard on January 10, of this year.

Unusual interest attaches to the launching of these two steamers within a few weeks of each other, as they are the first vessels to be built in the United States exclusively for third class, transatlantic, passenger traffic. Both of these steamers have been built for the United American Lines, Inc., and are intended for that company's third class passenger service between New York and Hamburg, recently inaugurating the sailing of the *Mount Clay,* formerly the *De Kalb.*

This service marks a distinct departure in handling third class or immigrant traffic between Europe and America. The vessels are fitted out with a view to giving passengers of this class comforts and conveniences that they have not heretofore enjoyed. There are comfortable staterooms with two, four, six and eight berths, as well as dining saloons, waiting rooms and smoking rooms.

As the ships are devoted to handle one class of passenger travel, the passengers have the freedom of all the decks. The following is a description of the *Mount Carroll* and *Mount Clinton*:

The original design of these vessels covered the construction of a three-decked cargo vessel of the following dimensions:

Length overall	457 feet 0 inches
Length between perpendiculars	440 feet 0 inches
Beam, molded	57 feet 0 inches
Depth to shelter deck	39 feet 0 inches
Draft	28 feet 9 inches
Deadweight	10,500 tons

The vessel is constructed on the transverse system of framing and was divided originally by transverse bulkheads into five cargo holds and lower 'tween deck space. The space between upper and shelter decks was not divided into separate compartments. The machinery space is located amidships. Fuel oil is carried in inner bottom tanks, except the tank under the engine room, which is arranged for reserve feed water. A deep tank is built in aft of engine room and was originally fitted for fuel oil or water ballast. When it was decided to carry passengers this tank was fitted for fresh water.

As completed for emigrant service the vessel will have accommodations for 1,294 passengers and a crew of 141. The space between upper and shelter decks contains 20 two berth rooms, 94 four berth rooms, 12 six berth rooms, 2 eight berth rooms and one open compartment with 28 berths. Men's and women's general hospitals and infectious wards, dispensary and room for hospital attendant are located in this deck space. Main dining saloon, galley, bakery, butcher shop, pantries and a dietary kitchen are on the upper deck.

Quarters for 762 passengers are provided in the five compartments on the lower deck. All of this space is made available for carrying cargo by the removal of berths and stanchions. An auxiliary dining saloon and a small bar room were provided on shelter deck by extending the deck house.

Access to passengers' accommodations is provided by means of a stairway from auxiliary dining saloon and booby hatches placed in the corners of cargo hatches. Accommodations for officers are provided in deck houses amidships. Crew's quarters are situated aft on upper deck and stewards and other members of commissary force are berthed amidships on lower deck. Refrigerator, linen rooms and store rooms located in No. 3 hold and on flat built here especially for this purpose.

The propelling machinery consists of geared turbines of 4,200 shaft horsepower in conjunction with four oil fired Scotch boilers, with which a speed of 14 knots is expected. The vessel has oil bunker capacity for 9,500 miles, which will permit her to make a round trip without re-fueling and with ample reserve.

For cargo handling there are eight 8¼ inch by 10 inch steam winches for handling general cargo and two 10 inch by 12 inch compound geared winches at the forward hatch for handling heavy loads in conjunction with a 30-ton boom.

For lighting, and furnishing power to various small motors and fans, there are three 20 kilowatt electric generators in the dynamo room, each directly connected to a steam engine. One of these generators is a spare. There is an 18 inch searchlight mounted on top of pilot house, and ample lighting fixtures distributed throughout the passengers' and crew's accommodations and also on deck for handling cargo at night. In addition to the steam generators there is a 15 kilowatt emergency generator located on the bridge deck, connected to a gasoline engine, and arranged for lighting the accommodations and decks for operating the wireless in case of accident in the engine room.

For fire extinguishing, a system of steam smothering is provided for the cargo holds, and hose lines are provided for reaching all parts of the decks and quarters, connected to a large steam fire pump in the engine room. In addition to this there is provided an automatic fire detecting system for giving the alarm and location of a fire in any part of the vessel.

All parts of the accommodations are heated by steam and, in addition, a forced system of ventilation is provided. The sanitary arrangements, washrooms, etc., are in accordance with the latest practice and of ample size.

The refrigerating system consists of two 8-ton ammonia refrigerating machines located in a gas-proof compartment off the engine room, and arranged to operate on the brine circulation system, thus eliminating the danger of ammonia fumes getting about the ship. Either one of these machines has sufficient capacity to maintain the desired temperatures in the refrigerating rooms, which eliminates the risk of provisions spoiling, due to a breakdown. The refrigerator rooms are large enough to carry sufficient provisions for a round voyage without replenishing.

The *Mount Carroll* will be placed in service on the New York-Hamburg Service on April 5 and the *Mount Clinton* will be added a few weeks later.

The United American Lines operate this service in connection with the Hamburg-American Line, which will place three steamers on the route during the early summer, permitting regular weekly sailings to Hamburg.

MARINE EXPOSITION AT PHILADELPHIA DURING THE WEEK BEGINNING MARCH 14

The American Marine Exposition will be held in the First Regiment Armory, Philadelphia, during the week beginning March 14. It is planned to make this exposition of such proportions that it will be of national significance. Arrangements have been made for the attendance of national, state, and city officials. Figures of international reputation in the maritime world will be on the speakers' platform on the opening day. Among the public men who are to be present and take part in the opening exercises are Governor Sproule, Mayor Moore, Director Sproule, of Wharves, Docks and Ferries, and the heads of leading shipbuilding concerns in and around Philadelphia. Admiral Benson, chairman of the United States Shipping Board, has written to the management of the American Exposition expressing his desire to be present, in which event he will be one of the principal speakers.

Aside from its business aspect, the exposition will be so held that it will present a unique and interesting spectacle in a story of the American merchant marine told in graphic form. More than 15,000 feet of moving pictures depicting every phase of shipping, shipbuilding, salvaging and other maritime activities will be shown.

A program of specialties for each night has been arranged, March 14 being designated as Cramp's night; March 15, Sun night; March 16, Merchant's night; March 17, New York Ship Night; March 18, Pusey & Jones night; March 19, Philadelphia Navy Yard, Hog Island and Mathis night.

The list of exhibitors who have booths at this exposition includes the most prominent concerns that do business in shipbuilding, and among those who have already contracted for space are the following:

American Car & Foundry Co., American Brass Company, American Blower Company, American Bitumastic Enamel Co., American Society Marine Draftsmen, Atlantic Drier and Varnish Company, Atlas Crucible Steel Co., American Insulation Company, American Ship Supply Company, Automatic Transportation Co., Bethlehem Shipbuilding Corp., Bernstein Mfg. Company, B. Binswanger Company, Bridgeport Brass Co., Brunswick Refrigerating Company, Bituco Mfg. & Chemical Company, R. M. Baily Company, Chase Metal Works, Crane Company, Chicago Pneumatic Tool Company, Delco Light Products Company, J. H. Day Company, Dayton Pneumatic Tool Company, Davis-Bournonville Company, Eastern Machinery & Equipment Company, Ford & Zendig, Foster Engineering Company, Frecker Brothers, France Packing Company, Fisher Machine Co., M. Furstenau, Glenwood Tile Company, Hyde Windlass Company, Hadfield-Penfield Steel Company, K-G Welding & Cutting Company, Keasbey & Mattison Company, Kean, Sharon & Company, J. P. Christensen, Charles E. Lindh, Inc., Luckenbach Steamship Company, J. E. Lonegran Company, John Baizley Iron Works, Marine Equipment & Supply Co., McCambridge Company, Magnesia Assn. of America, Maritime Register, Marine Review, Morris Metallic Pkg. Company, Marine Decking & Supply Company, Merchants Shipbuilding Corp., Marine Engineering, John J. Mathews Company, Marshall Brothers, Merritt & Chapman Derrick & Wrecking Co., Marine News, Norwalk Lock Co., J. L. Mott Iron Works, New York Shipbuilding Corp., Eugene E. Nice, National Lead Company, National Bituminous Enamel & Paint Co., Pusey & Jones, Paschall Oxygen Company, Pneumercator Company, Phosphor Bronze Company, Row & Davis, Engineers, Inc., Paul S. Reeves Company, Seamen's Church Institute, Standard Underground Cable Co., Schuette & Koerting Co., Sun Shipbuilding Company, Scovill Mfg. Company, Sherwin Williams Company, Strawbridge & Clothier, George W. Smith & Company, Schlorer Mfg. Company, Thorne Pioneer Metallic Pkg. Co., Uhler & English, United Cork Company, Union Steam Pump Company, United States Navy, United States Rubber Company, Valentine & Company, J. B. Van Sciver Company, Weisbrod & Hess, Edgar T. Ward's Sons Company, White Fuel Oil Company (Todd Shipbuilding Corp.), York Mfg. Company, Vulcan Engine Works.

ALL-AMERICAN TERMINAL

Greatest of its Kind Planned for Hamburg, Germany

An American steamship terminal of the most modern type is to be erected at the port of Hamburg, Germany, according to an announcement made a few days ago by President P. A. S. Franklin, of the International Mercantile Marine Company. The terminal will be built with American capital, equipped with American machinery, and used exclusively by American steamers.

Adjacent to the Hamburg-American piers, the American terminal is expected to excel them in equipment and efficiency, and will rate as the finest in Germany. It will be built on the Ross Quay, one of the largest dock structures at Hamburg that remained incomplete at the beginning of the war, to which the American Line has taken a long lease. It will have a total length of nearly half a mile, with depth of water alongside to accommodate the largest passenger liners now operated in the American Lines service from New York. Sheds will be built of concrete and steel, 656 feet long, having a ground floor area of 2¼ acres. The latest type electric cranes will be installed, and trackage will be laid to connect the terminal with through rail lines by which American products will be moved to interior points in Germany, and to Czecho-Slovakia, Rumania, and other central European countries. The ships that will use this new terminal are now docking temporarily at piers secured on hire from the civic authorities of Hamburg.

TWO AMERICAN SHIPS TAKE INITIAL PLUNGE

The twin screw steel steamer *Henry D. Whiton* was launched on February 26 by the Newburgh Shipyards, Inc., at Newburgh, N. Y. The vessel is 356 feet long and of 7,000 deadweight tons. The ship is built to the order of the Union Sulphur Company, of New York, and special interest attached to the launching in view of the many innovations entering into the design of the vessel which will be used in special service for the economic handling and transporting of sulphur and similar cargoes in bulk.

The Blue Hen State

The steamship *Blue Hen State* was launched at the Camden yard of the New York Shipbuilding Corporation on February 23. The vessel is the last of a group of seven similar passenger and cargo liners built for the United States Shipping Board which are in operation in the north Atlantic and transpacific service.

The ship measures 522 feet over all with a beam of 62 feet; when completed will have a loaded gross tonnage of 21,900 and will be equipped with triple expansion engines developing 7,000 horsepower, and a speed of 14 knots.

The *Blue Hen State* and the steamship *Centennial State* launched last January, will be operated by the Ward Line between New York and Spanish ports by way of Cuba.

Election of Officers

Following the annual meeting of the executive committee of the National Association of Engine and Boat Manufacturers, Inc., 29 West 39th Street, New York City, the following officers were elected to serve for the ensuing year: President, Henry H. Sutphen; first vice-president, John J. Amory; second vice-president, Charles R. Criqui; third vice-president, George F. Lawley; treasurer, James Craig.

Pacific Mail Ship Launched

The steamship *Solanas*, built for the Pacific Steamship Company, San Francisco, Cal., by the New York Shipbuilding Corporation, Camden, N. J., was recently launched successfully.

LAUNCHED ABROAD

The steel cargo steamer *Vechtdyk*, built to the order of Messrs. Solleveld vander Meer and T. H. Van Hattum's Steamship Company, has been launched by Werf Gusto, Firma A. F. Smulders, Schiedam, Holland. The steamer is of 6,500 tons deadweight, is 359 feet long and is the third of four vessels of the same type under construction for this firm. Following this launching the keel was laid for one of two cargo vessels of 7,200 tons deadweight each on order by the steamship company, Triton, of Rotterdam.

The oil tank steamer *British Viscount* has been launched from the Neptune shipyards of Swan, Hunter & Wigham Richardson, Ltd., Newcastle-on-Tyne. The ship is being built to the order of the British Tanker Company of London, and is 455 feet long. She is designed to carry over 10,000 tons of oil.

At Southwick-on-Wear the same company has launched for the Atlantic Fruit Company of New York the steamship Saint Mary. This vessel is 270 feet in length, and will be equipped with triple expansion engines with boilers to be fired either with coal or oil fuel.

DEVELOPMENT PLANS

Present plans of the Transportation Committee of the Ingersoll Engineering & Construction Corporation, Liberty Building, Bridgeport, Conn., having to do with the reopening of Steeplechase Island as a summer resort this year, call for a ferry slip to be built at the Stratford Avenue dock, a floating dock and furnishing sufficient water with the present Seaview Avenue dock and ferry slip and floating dock to be added to the present pier at Steeplechase Island.

Dredging plans for the same enterprise call for the removal of approximately 20,000 cubic yards of material, the majority of which will be for the ferry slips and docks at the Steeplechase Island side and the balance directly in front of the Seaview Avenue dock, so as to permit the floating of the floating dock to be installed in connection for boats of 6 feet draft or less to anchor there.

Floating docks have already been purchased and it is expected that $50,000 or $60,000 will be expended in rebuilding the present docks and the building of the new ones outlined. Bids for the work will probably be opened within the next eight or ten days, according to official information obtained by Marine Engineering from General Manager Fred W. Pearce, of Josiah Pearce & Sons, Detroit, Mich., amusement builders and operators.

FORDONIA CONTRACT CALLS FOR DIESEL ELECTRIC DRIVE

The contract for the installation of motors, generators and similar electric equipment in the American freight steamer Fordonia, of the American-Mediterranean Steamship Company, was awarded to the General Electric Company on March 3, it has been officially announced. The ship is also to have two Ansaldo internal combustion engines, which will be installed by the Todd Shipyards Corporation.

BIDS FOR MOMUS WILL BE OPENED APRIL 7

Bids for the reconditioning of the Southern Pacific Company's freight and passenger ship Momus, which is to have new boilers and oil-burning equipment to replace the present coal-burning system, will probably be opened on April 7, according to announcement to-day. Superintending Engineer A. S. Hebble, of the Southern Pacific Company, arranged the plans and specifications, and Babcock & Wilcox boilers fitted with B. & W. oil burners will be installed.

FRENCH SHIPBUILDING

Statistics recently published show that the French Mercantile Marine has already been restored to its pre-war basis. The Rapport Generale sur l'Industrie Francaise states the total merchant tonnage on December 31, 1919, was 2,400,896 tons, or approximately the same as prior to the war.

BUSINESS NOTES

The Consolidated Instrument Company of America, 461 Eighth Avenue, New York City, announces its formation "to render manufacturers, engineers, and designers a complete engineering sales service in connection with all types of speed indicating and recording instruments and devices." The company controls exclusively the entire American distribution of the Jones tachometers and various other recording devices.

It is announced that the New York Shipbuilding Corporation, Camden, N. J., has placed an order with the Matthews Engineering Company, of Sandusky, Ohio, for 18 Matthews full automatic self-starting units which are for use on the top deck of ships to take care of wireless, deck passage lighting and the lighting of davits for emergencies such as recently happened to the Spanish steamer *Santa Isabel,* which was wrecked while the passengers were asleep.

Announcement is made by the Atlas Valve Company, Newark, N. J., that they have added to their line of valves, pumps, governors, pressure regulators, etc., the "Ideal" automatic pump governors, having acquired sole patents and rights to manufacture by purchasing from the Ideal Automatic Manufacturing Company. This pump governor has been approved by the United States Navy and by the National Board of Supervising Inspectors of Steam Vessels for controlling certain exacting operations.

A. C. Rimmer, consulting engineer and naval architect, 149 Broadway, New York, has been made district sales manager for the Northwest Engineering Works, of Chicago, Ill., to concentrate particularly on the Northwest crawler crane, which, like the war tanks, travels under its own power on two manganese steel crawler type wheels. Its lifting capacities range from 5,200 to 20,000 pounds.

It is announced that Barimar, Ltd., 10 Polen Street, London, in addition to the overseas branches they are now maintaining, have established new service depots in Birmingham, Manchester, Newcastle and Cardiff at each of which their special metallurgical process will be in operation.

The Chicago Pneumatic Tool Company announces the resignation of Mr. H. L. Dean, formerly manager of the compressor and engine sales division. Mr. J. F. Huvane has been appointed as eastern manager of this division with headquarters at 6 East 44th Street, New York City, and Mr. G. C. Vanden Boom as western manager of the division with headquarters at 300 North Michigan Boulevard, Chicago.

The C. H. Wheeler Manufacturing Company, of Philadelphia, Pa., manufacturers of condensers, pumps, feed water heaters and water cooling apparatus, has opened a branch sales office in the Leader News Building, Cleveland, Ohio. Mr. W. K. Eicher is in charge.

The Hooven, Owens, Rentschler Company, of Hamilton, Ohio, announce the appointment of the John Fensen Company, Richmond, Va., as their representative in the Virginia territory; the Sunderland Machinery and Supply Company, Omaha, Nebr., as the representative in the Omaha district, and Mr. Walter T. Paine, as representative in the Boston district.

Announcement is made of the appointment of George L. Cook as manager of block distribution for the Marine Decking & Supply Company, manufacturers, contractors and engineers, of Philadelphia, Pa.

The southern office of the Consolidated Shipbuilding Corporation, Morris Heights, N. Y., designers and builders of motor yachts and their machinery, will be reopened this season at 1100 Boulevard, Miami, Fla., under the direction of Mr. Clement Gould Amory.

Mr. S. J. Lenher, president of the Lenher Engineering Company, New York, who assumed the general management of the S. Flory Manufacturing Company, Bangor, Pa., upon the death of Mr. Samuel Flory, has been elected president of the S. Flory Manufacturing Company, and will direct its affairs from the home office at Bangor.

The Locomotive Superheater Company has acquired the patents and business of the Locomotive Feed Water Heater Company. The Locomotive Superheater Company will conduct the further application of the apparatus for preheating feed water, through its regular engineering, inspection and service organizations, to which has been added the operating organization of the Locomotive Feed Water Heater Company. This consolidation of resources and effort promises more intensified development and better service to the railroads.

George J. Blanton, who for the past four years has been connected with the Engineering Sales Department of Chain Belt Company, Milwaukee, has been made New York District Manager, with offices at 50 Church Street. Before joining the "Rex family" in 1917, Mr. Blanton was associated with the General Electric Company for eight years. He is a graduate of the University of Michigan Department of Mechanical and Electrical Engineering, class of 1909. He will leave immediately to take charge of the company.

The office managers of the several district offices of The Cutler-Hammer Manufacturing Company were in attendance at a general sales meeting held in Milwaukee, during the week of February 14 to 19, under the direction of W. C. Stevens, sales manager of the firm.

Malcolm R. Maclean has resigned as secretary and sales manager of the Duquesne Steel Foundry Company to become sales manager, castings division, Penn Seaboard Steel Corporation, Philadelphia.

Mr. E. L. Mills, formerly in charge of the sales of the Klaxon marine signals and telephone equipment in the New York district, has been appointed district agent for Klaxon Industrial Products in eastern Pennsylvania and in adjacent New Jersey, Delaware and Maryland. His temporary address is 248 North Broad Street, Philadelphia, Pa. Mr. Paul M. Farmer succeeds Mr. Mills in the New York district.

Mr. Harry L. Oviatt has been appointed traveling representative of the Armstrong Manufacturing Company, of Bridgeport, Conn., manufacturers of pipe threading tools and taps. Mr. Oviatt has been with the Bullard Machine Tool Company for the past thirteen years; for the past three years connected with the advertising department.

Marine Construction News of the Month

Ship Contracts—New Ship Concerns and Shipyard Improvements—Terminal Projects—Government Contracts

SHIPS AND SHIPBUILDING

Ship Repair, Baltimore, Md.—The H. E. Crook Company is reported to have been awarded the contract for repairing the Shipping Board steamer Otho.

Foreign Orders.—According to a report from Montreal, shipping interests in Jugo-Slavia are desirous of having some ships of from 2,000 to 15,000 tons built in Canada.

Overhauling Vessel, Jacksonville, Fla.—The steamship Jacksonville has been put into dry dock at the Merrill-Stevens yard for minor repairs and will also be scraped and painted.

Steamboat, Sarasota, Fla.—According to a recent report, the Chamber of Commerce is in the market for a steamboat about 100 feet in length, 4½-foot draft, suitable for carrying both freight and passengers.

Sidewheel Steamer, Memphis, Tenn.—According to an announcement made by Captain Peters Lee, the Lee Line will build a 160-foot sidewheel steamer capable of handling 700 tons of freight, for which it is expected the contract will be let next spring. The vessel will cost about $100,000.

Overhauling Large Liner, Seattle, Wash.—At an expense of nearly $125,000 the Pacific Steamship Company has authorized the complete overhauling and renovating of the coastwise passenger liner President, which work is now nearing completion at the plant of the Todd Dry Docks Corporation, Harbor Island.

Tugs and Barges, Algiers, La.—It is reported that the Johnson Iron Works, Drydock & Shipbuilding Company, Inc., has received a contract to construct towboats and barges for the Gulf Refining Company. The equipment to be furnished includes two steel barges, one steel hull and one towboat.

Repairing Steamer, Victoria, B. C.—The largest and most expensive repair job to be carried out in British Columbia is that of the G. T. P. steamer Prince Rupert, which was floated after two months' salvage operations and towed to the Yarrows, Ltd., yard. The job will require 115 days for completion and will cost $258,000.

Freight Steamers, Vancouver, B. C.—It is reported that the Coughlan Shipyards contemplate building two 8,800 deadweight ton standard freight steamers to add to their own fleet, and it is expected that they will be ready by next summer. The Kingsley Company, Vancouver, B. C., plans another vessel for its San Francisco run.

Submarine Chaser for Fireboat, Boston, Mass.—It was learned that the Navy Department has turned over to Boston a submarine chaser which will be reconditioned and converted into a fire-fighting craft. Fire apparatus will be installed and the necessary changes in the boat made, and it is announced that this work will be done in Boston.

Repairing Steamer, Mobile, Ala.—The steamship Dade County, of 5,076 tons deadweight, has been placed in dry dock by the Alabama Dry Dock & Shipbuilding Company, where she will undergo extensive repairs made necessary by damage from fire in New Orleans last month. One hundred shell plates will be removed, as well as a number of deck plates. Work is to be completed in sixty days.

New Steamship Considered, San Francisco, Cal.—Information obtained recently was to the effect that the Oceanic Steamship Company of San Francisco, Cal., has been contemplating the building of a new ship. In an official announcement to MARINE ENGINEERING the Oceanic Company stated, however, that the matter of building has not yet been definitely decided, owing to present conditions.

Repairing Vessel, Hoboken, N. J.—A contract for repairing the Southern Pacific steamship El Occidente, which was damaged as a result of a fire on December 23 at Galveston, Texas, was awarded to the Tietjen & Lang Dry Dock Company, of the Todd Shipyards Corporation. Removal of 130 plates will be necessary. The successful bidder was awarded the contract on a price of $150,000 and forty days.

Electric Drive for Vessel, Brooklyn, N. Y.—The contract for installation of electric drive in the United States Shipping Board ship Archer, 12,000 tons deadweight, to replace the war emergency geared turbine equipment, was awarded to the Tebo Yacht Basin Company, Brooklyn, on a bid of $83,700. The work is to be completed by May 2. The Archer is a sister ship of the Eclipse and the Invincible.

Reboilering the Plymouth, Newport, R. I.—The steamer Plymouth, of the New England Steamship Company, has been taken from her Eastern run and is being reboilered at the company's repair plant, Newport. Six Babcock & Wilcox boilers, having a heating surface of approximately 16,500 square feet, will be installed. The Plymouth will probably be back in service in time for the beginning of the spring business.

Tankers, San Francisco, Cal.—That contracts for the building of four oil tankers for the Union Oil Company will be let following the sale of three smaller tankers, was the announcement made recently, and credited to A. O. Pegg, superintending engineer for the company. Three of the new tankers will be of 12,500 tons, with a capacity of 85,000 barrels of oil each, and one of 7,500 tons, with a capacity of 50,000 barrels.

Steamer to be Overhauled, Copenhagen, Den.—The steamer Oscar II, of the Scandinavia-American Line, has been sent to Messrs. Burmeister & Wain's yard, at Copenhagen, for overhauling and she will at the same time undergo extensive alterations. In future it has been decided that she shall have only two classes for passenger, namely, cabin and third-class, instead of as at present, first and second classes, which will be converted into one.

To Equip Steamer with Electric Drive, New York.—The American freight steamer Fordonia is to be equipped with Diesel electric drive, according to announcement of McDonnell & Truda, New York agents for the American Mediterranean Steamship Company. The engines are to be two Ansaldo San Giorgio Diesels, 4-cylinder, 2-cycle and 500 brake-horsepower, and are now on their way here from Italy. The installation will be by the Todd Shipyards Corporation.

To Overhaul Vessels, San Francisco, Cal.—The entire fleet of eleven German barks recently bought by the Robert Dollar Company will be thoroughly overhauled and repaired, after which they will be placed under American registry and put in general shipping service. One of the sailers, the Hans, has already arrived in San Francisco, and three more are expected soon. The entire fleet is expected to be brought to San Francisco toward the end of April or the middle of May.

Auxiliary Schooner.—W. Starling Burgess, Portland, Maine, is designing an auxiliary schooner, to be one of the largest ever built, for a member of the New York Yacht Club, whose name for the present is withheld. The vessel is to be built of steel and will be 210 feet overall in length, and 160 feet waterline. The three-pole masts will spread 16,000 square feet of sails. A steam engine of 750 horsepower will furnish auxiliary power for the vessel, which is intended primarily for ocean cruising.

Bids for Ferryboats, San Francisco, Cal.—It is announced by President Forbes H. Brown, of the Six-Minute Ferry Company, that the company will be ready to accept bids on the construction of three boats within a week or so. Hull construction of the new boats will be similar to that of the Edward T. Jeffrey. The superstructure of the main deck will be high enough to clear the largest moving vans of any of the bay cities, and each boat will have ample room for eighty machines, arranged in three rows on each side of the boat.

Engines for Barges, Oakland, Cal.—It is announced that the Skandia Pacific Oil Engine Company has been awarded contracts to install Diesel engines in new canal boats to be used on the Erie Canal. Installing of these engines heralds the passing of the mule and the towpath on the Erie Canal as a means of propelling boats through New York State. The plans of the state include the construction of canal boats, 250 feet long, 36 feet beam and 14 feet deep. The barges will be built in Duluth and the engines shipped from California. The contracts are for $150,000.

Activities in Halifax.—The Halifax Shipyards, Ltd., Halifax, N. S., have two ships of 10,500 tons each in the course of construction and it is expected they will be delivered next June. In addition, the company has a large amount of repair work on hand. It is also reported that the company has in prospect orders for the construction of five large oil tankers. This work would be sufficient to keep the Halifax yards, as well as those of the Davie Shipbuilding & Repair Company, at Lauzon, Que., and the Tidewater Shipbuilders, Ltd., at Three Rivers, Que., busy during 1921.

Turbines Instead of Diesels to be Installed.—The Bethlehem Shipbuilding Corporation has abandoned the plan of equipping its four new 20,000-ton ore carriers with Diesel engines. It has been learned that the corporation has decided to install steam turbines instead of the internal combustion engines. No announcement was made by the company of this change in decision, but it is reported that the Bethlehem Union plant has been ordered to start on the construction of the turbines for these vessels, two of which will be built near San Francisco, while two will be produced at the Sparrows Point plant of the Bethlehem Corporation.

Yards Busy on Private Work, San Francisco, Cal.—A review of the San Francisco Bay shipyard situation shows the industry here has settled down to a business-like basis. The Bethlehem Shipbuilding plant has started work on two $5,000,000 ore carriers, which will require a year for completion. The Moore Shipbuilding Corporation has started on a 16,340-ton tanker for the Southern Pacific Company to be used on the Atlantic Coast, while four 10,000-ton vessels are now on the ways. The new plant of the Union Construction Company has started work on a 10,200-ton tanker for the Anglo-Saxon Petroleum Company. The yards are also busy on a vast amount of ship repair work.

To be Converted into Oil Burner.—The present coal-burning equipment of the Southern Pacific Company's freight and passenger ship Momus will be replaced by new boilers and oil-burning equipment early in the spring. It is expected that the Momus will run until April. Bids for the reconditioning of the ship will be opened in the near future. Arrangement of the plans and specifications have been made by Superintending Engineer A. S. Hebble of the Southern Pacific Company. Babcock & Wilcox boilers fitted with B. & W. oil burners will be installed in the ship and the boilers will have a heating surface of approximately 22,680 square feet and 2,250 square feet of superheating surface.

Tanker, Oakland, Cal.—The keel for a 16,340 deadweight ton tanker, to be built at an approximate cost of $3,250,000, was laid last month at the yard of the Moore Shipbuilding Company for the Southern Pacific Company, New York. She will be 520 feet overall length, 71 feet beam, 39 feet deep, to load to 28 feet, and will be fitted with Scotch boilers having 220 pounds working pressure, to operate quadruple expansion engines. The pumping outfit will consist of two compound horizontal duplex oil pumps with a capacity of discharging 6,000 barrels an hour. The vessel was designed by A. S. Hebble, superintending engineer of the Southern Pacific Company, and will be built on the Isherwood system of longitudinal construction.

Reconditioning Steamers, New York.—Plans and specifications for extensive reconditioning of the steamships America and George Washington, of the United States Mail Steamship Company, Inc., 45 Broadway, New York, have been completed preparatory to the asking for bids on these two ships. It is planned to put these steamers in first-class condition in order that they may compete with the very best passenger liners. While no definite figures could be obtained, it is understood that the work of putting these ships into the desired condition will occupy a considerable length of time and will cost in excess of $2,000,000. The George Washington is a vessel of 15,379 tons and the America of 13,637 tons.

Repair Contract, Brooklyn, N. Y.—The steamship St. Louis, at one time crack transatlantic liner, has been sold at auction for $250,000 to the Anderson Company, of Montreal, Can., and has been taken to Erie Basin, where the Robins Dry Dock Company will put the ship in condition so that she may be taken to England, where, it is understood, she will be placed in British service under the British flag. The steamer Narragansett, which for several years was engaged in service through Long Island Sound between New England ports and New York, is also at the Robins plant undergoing reconditioning preparatory to being taken abroad by European interests. During the war the Narragansett served in the English Channel.

Fletcher Yards Busy, Hoboken, N. J.—Reconditioning of the steamship Kilpatrick, recently used as an army transport, has been started by the W. & A. Fletcher Company, to whom the contract was given by Stephen Stephanidis, 24 State street, New York, who will operate the ship as a passenger and freight steamer, running between New York, Constantinople and Piraeus. The contract will be completed in thirty days. Work has also been started on extensive reconditioning of the 3,275-ton ship Suriname, of the United Fruit Company. This job includes, among other things, insulation, building up of the stern and a new deck house. It is expected she will be finished about the middle of March. The Fletcher Company will also recondition the United Fruit ship Coppename, starting the work in March and completing it in May.

New Vessel Construction, New York.—Twelve vessels are at present in various stages of construction under the supervision of Whittelsey & Whittelsey, naval architects, of 17 Battery Place, New York City. Ten of these ships, three tankers and seven embarkation steamers, will be of concrete, for the war department, and are being built by the Newport Shipbuilding Company, Wilmington, N. C. The tankers will be of 3,500 tons, 300 feet long by 44 feet beam, by 24.6 feet depth, to be equipped with 1,500 horsepower engines. The embarkation steamers will be double deck, 150 feet long, each to be equipped with two 450-horsepower Winton Diesel engines. One steel steamer, 135 feet long, is being constructed for the International Petroleum Company of New York, to be used for mooring and maintenance service. A second steamer for the Atlantic Gulf Oil Company is being built by Kyle & Purdy, of City Island, New York.

SHIPYARDS AND DRYDOCKS

New Shipyard, Huntington, W. Va.—It is reported that J. P. Hetherington will construct a shipyard to build ferryboats.

Dry Dock Crane, Ogdensburg, N. Y.—The St. Lawrence Marine Railway Company plans to install a 20-ton electric dry dock crane.

Shipyard Addition, Morris Heights, New York.—The Consolidated Shipbuilding Corporation will build a one-story power house at its works.

Drydock, Akron, Ohio.—The State Board of Public Works, State House, Columbus, Ohio, plans to build a concrete drydock near Akron, involving the expenditure of about $20,000. Kinnear & Whitlock, State House, Columbia, are the engineers.

New Building, Detroit, Mich.—The Belle Island Boat & Engine Company, 2096 East Jefferson Avenue, is planning the erection of a new one-story factory on East Jefferson Avenue. The plant will be reinforced concrete and brick and 90 by 150 feet.

Repair Plant Sold, San Francisco, Cal.—Advices from San Francisco announce the acquisition of the oldest shipsmithing establishment on the Pacific Coast, the firm of Muir & Symon, by John M. Mooney and James F. Young, both formerly of the Skinner & Eddy Corporation.

Marine Railway, Havana, Cuba.—The Munson Steamship Line will build a marine railway for its own use at Mariel Bay, which is located a few miles from the port of Havana. The marine railway will be constructed to enable the company to keep its ships operating efficiently.

Shipyard Additions, Elizabeth, N. J.—The Bethlehem Shipbuilding Corporation, Front Street, has plans under way for a number of additions to its Moore shipbuilding plant, to cost more than $800,000, and it is expected that construction will begin in the early summer.

New Shipyards, Buenos Aires, Arg.—An Argentine company, with a capital of 50,000,000 pesos, is being formed at Buenos Aires, Argentine, S. A., with the object of establishing shipbuilding yards at the port of Carmen de Patagonia, and constructing vessels for the European trade. It is reported that a local German firm will provide some of the capital.

Floating Dry Dock Wanted, New York.—On behalf of a client, J. R. Wemlinger & Company, Inc., engineers, 140 Broadway, New York, is in the market for a floating dry dock to accommodate vessels up to about 6,000 tons. This dry dock is to be complete with all necessary equipment, and delivery will be taken at any Atlantic or Gulf port, preferably the latter.

New Shipyard to Be Built, Tottenville, S. I.—The Union Shipyards Corporation is arranging for the construction of a plant on property fronting Staten Island Sound, which will be used for the repair and construction of tugs, barges, lighters and other vessels. The company has a tract of about eight acres and is reported to be in the market for a locomotive crane.

Building Dry Dock Plant, North Bergen, N. J.—The Lord Dry Dock Corporation, 105 West 40th Street, New York, has construction under way on its new dry docks at Woodcliffe. A number of buildings will also be erected, including machine shops, metal-working plant, woodworking shops and other structures. The project will involve the expenditure of about $5,000,000.

Repair Base, San Diego, Cal.—After many months of waiting, the Navy Department has finally taken over the former concrete shipyard of the Pacific Marine & Construction Company, and has started converting the yard into a fleet repair base. The base, designed to meet the requirements of the destroyer, mine sweepers, and other craft permanently based here, will be equipped with a marine railway, machine and woodworking shops and several concrete piers.

Shipyard Addition, Brooklyn, N. Y.—Stephen Ransom, Inc., 518 Hamilton Avenue, has awarded a contract to the Wharton Green Company, 37 West Thirty-ninth Street, New York, for the construction of a one-story machine shop, 120 by 160 feet, to cost about $200,000. The Wharton-Green Company was also awarded another contract by the same firm for the construction of a four-story building at its marine repair works. The latter building will be 80 by 200 feet.

Shipyard Improvements, Chester, Pa.—Numerous improvements are contemplated by the management of the Chester yard of the Merchant Shipbuilding Corporation during 1921, including additional machine tools in six of the biggest shops; enlargement of shipways to take care of building larger hulls, and safety devices throughout the yard in general. Additional machinery is contemplated for the pipe, pattern, joiner, blacksmith, machine and fabrication shops, including jib cranes and electric hoists, for the handling of fabricated material.

PORT IMPROVEMENTS

Docks, Houston, Tex.—The city is having plans prepared by the city engineer for remodeling the municipal cotton docks.

Channel, Mobile, Ala.—The Chamber of Commerce is interested in improving the channel at Bayou la Batre. Major Earl North is United States district engineer.

Docks, Etc., Amherstburg, Ont.—C. Wigel & Sons, River Front, plan to build a warehouse and new docks in connection with their flour mills, involving expenditure of about $40,000.

Dredging, Miami, Fla.—The city has voted bonds to the amount of $100,000 to deepen the 300-foot channel slip from 15 to 22 feet, and the 1,000-foot channel slip from 10 to 17 feet. C. W. Murray, Miami, is engineer.

Docks, Melbourne, Australia.—Work will soon commence on the first part of the development program planned for the port of Melbourne, Australia. Four new docks to cost £6,000,000 will be constructed, and six others will be constructed later as required.

Docks, Slips, Etc., Norfolk, Va.—A new steamship line, to be known as the Hampton Roads Transportation Company, has been chartered under the laws of Virginia, with a capital of $500,000, to operate a ferry line for both passenger and automobiles between Willoughby Spit and Phoebus, Va., early in the spring. Plans for the building of the docks and slips are already out, and bids for their construction will soon be opened. Mr. John N. Haden, Seaboard building, Norfolk, Va., is president.

GOVERNMENT WORK

Pier, Charleston, S. C.—Specification 4363, the Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to build a reinforced concrete pier.

Heating System, San Diego, Cal.—Specification 4366, the Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to install a heating system.

Refrigerating Equipment, Newport, R. I.—Specification 4363, the Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to install a refrigerating system at the Naval Hospital.

Electric Distributing System.—Specification 4369, the Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to install an electric distributing system for Slips 2 and 3 at Philadelphia, Pa.

Foundation for Crane Runway, New York.—Specification 4362, the Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to build foundations for steel storage crane runway at New York.

Radio Quarters, Mare Island, Cal.—Specification 4361, the Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to build radio quarters at Loma Point. Bids will be opened at the local navy yard.

Dump Scow.—The Engineer Office, United States Army, Room 15, Custom House, Norfolk, Va., will receive sealed bids until 12 o'clock noon, March 15, for the purchase of Dump Scow No. 25. Further information on application.

Steel Dump Scows, Pittsburgh, Pa.—The Dravo Contracting Company, Diamond Bank Building, has been awarded a contract for the construction of five steel dump scows by Colonel W. B. Ladue, Corps of Engineers, U. S. Army, Philadelphia, Pa.

Steel Hull, Nashville, Tenn.—United States Engineer Office, War Department, Second District, Custom House, Cincinnati, Ohio, has let a contract for constructing the steel hull for the snag boat Kentucky to the Nashville Bridge Company, Shelby avenue. The hull will cost $28,480.

Stern-Wheel Boat, Pittsburgh, Pa.—The Mississippi River Commission. First and Second Districts, Custom House, Memphis, Tenn., has let a contract for furnishing the stern-wheel steamboat Luther D. Griffith to J. Eichleary, Jr., Twentieth and Wharton streets, at a cost of $41,414.

To Deepen Channel, Galveston, Tex.—United States Engineers, C. L. Hall assistant engineer, invite bids for dredging the second section of the Houston Ship Channel to a depth of 30 feet, width 150 feet. An appropriation of $1,500,000 is recommended to complete depth to turning basin of 30 feet.

Naval Base to Be Expanded, Hawaii.—According to announcement made by Rear Admiral W. B. Shoemaker, who recently arrived at Pearl Harbor to take command there, the United States Naval Base in Hawaii is to be made capable of supplying and taking care of the entire Pacific fleet. Plans for expansion at Pearl Harbor now are under way.

Shipyard Improvement, Mare Island.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., is completing plans for a new plate and structural shape shop at the Mare Island Navy Yard. Bids for the foundation will be taken at once. A new local scrap yard to cost approximately $27,800, with handling equipment, is also included.

Wharf, Etc., Norfolk.—The United States Engineers, War Department, Washington, D. C., has let a contract for constructing a wharf at Norfolk to the Raymond Concrete Pile Company, 921 Munsey Building, Baltimore, Md., at $25,462.50, and the contract for dredging the Elizabeth River to the Norfolk Dredging Company, 217 Water street, at $17,000.

Electric Drive Equipments, Oakland, Cal.—The Coast Guard Service has placed orders for four electric drive equipments for cutters, which will be 3,000 horsepower synchronous motor type. The hull for the first cutter was recently laid at the yard of the Union Construction Company, which holds the contracts for the construction of all four cutters.

Machinery and Other Equipment, South Boston, Mass.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., is re-ising plans for its new building at the South Boston drydocks, to include the installation of a 50-ton steam locomotive crane. The work is estimated at a cost of about $200,000, including machinery, and bids will soon be asked.

Navy Repair Contract.—Announcement is made at Los Angeles, Cal., by Rear Admiral Welles, Commandant of the eleventh naval district, that contracts are about to be closed between the government and a Los Angeles shipbuilding company for repairs to more than 100 destroyers of the Pacific fleet. About $12,000,000, it was stated, will be involved in these contracts.

NEW INCORPORATIONS

Ambrose Lighterage & Transportation Company, Inc., 95 Booraem Avenue, Jersey City, N. J., has been incorporated with a capital of $200,000, to conduct a freighting, lighterage and transportation business.

Hampton Roads Transportation Company, Seaboard Building, Norfolk, Va. Capital, $500,000, with John N. Haden, president: W. B. Baldwin, treasurer; J. C. Dabney, secretary.

Fred E. Jones Dredging Company, Wilmington, Del. Capital, $250,000, to conduct river and harbor improvements.

Matthew Addy Steamship Commerce Corporation, Cleveland, Ohio, has changed its name to the Delaware Steamship & Commerce Corporation.

Miraflores Steamship Corporation, Dover, Del., has been incorporated with a capital of $650,000, to engage in ocean commerce.

New York-New England & Pennsylvania Lighterage Company, Inc., Wilmington, Del. Capital, $100,000, to purchase, charter, hire, operate, own, lease and dispose of vessels, ships and boats.

St. Mary Steamship Corporation Dover, Del. Capital, $650,000, to engage in ocean commerce.

Universal Ship Supply Company, 129 Tazewell Street, has been organized, with J. Garzia, president; J. Larrasquiru, vice-president; P. Astarbi, secretary-treasurer, and capitalized at $50,000.

The Mallory Diesel Electric Corporation, Dover, Del., has been incorporated with a capital of $100,000 to carry on a business of electrical and marine engineers.

The Keeler Transportation Line, Inc., New York, N. Y., has been incorporated with a capital of $500,000 for navigation, by E. A. Keeler, Shore Road, Whitestone, L. I.

Parkersburg Dry Docks Company, Wilmington, Del., was incorporated with a capital of $800,000 to build and do a general towing and river shipping business.

North American Steamship Company, Boston, Mass.; capital, $250,000.

Barr Shipping Corporation, Wilmington, Del., to build, own and operate boats; capital, $900,000.

East Coast Steamship Lines, Inc., Wilmington, Del., to build, own and operate boats; capital, $500,000.

Cox's Shipping Agency, Inc., Dover, Del., a general ship brokerage business; capital, $100,000.

Atlantic, Gulf & Mediterranean Steamship Corporation, Manhattan, navigation; capital, $100,000; incorporated by M. Finkelstein, 341 Stone Avenue, Brooklyn, N. Y.

Betts Lighterage & Wrecking Company, Boston, Mass.; capital, $100,000.

American Maritime Company, Boston, Mass., buying and selling vessels; capital, $50,000.

R. S. Brine Transportation Company, Boston, Mass., transportation and construction; capital, $400,000.

Warren Export Coal Company, incorporated under the laws of Delaware to do a general export business in cargo and bunker coal. W. A. Harriman, New York, has been elected chairman of the board.

The Baltimore Derrick & Salvage Corporation, Dover, Del., was incorporated with a capital of $300,000, to own and operate machinery for salvaging, by Louis E. Broom, Jr., Baltimore, Md.; James F. McLeod, Ridgewood, N. J.; Ralph E. Chapman, Brooklyn, N. Y.

The William Donovan Steamship Company has been formed at Aberdeen, Wash., with a capital of $190,000.

FOREIGN ACTIVITIES

To Improve Harbor.—The government of Brazil has provided an appropriation for harbor improvements at Pernambuco, according to recent reports.

Quay Extension.—R. W. Hawthorne, Leslie & Company, Ltd., have decided to make a quay extension of reinforced concrete to their Hebburn-on-Tyne shipyard. It will be 200 feet long and 40 feet wide.

Building Canals.—According to recent reports, the Ministry of Public Works of the Polish Government is constructing two canals; one of these is a circulatory canal located near Warsaw, and the other is being constructed in West Galicia.

Steamship Service.—The government of Holland introduced a bill into parliament to authorize during a period of five years an annual advance of approximately $291,665 for the support of direct steamship service between Holland and South Africa.

Graving Docks.—The formation of the Netherlands Dock Company at Amsterdam by a number of Dutch shipping companies and Amsterdam banks is announced. A site of 60 acres has been bought. Three graving docks (constructed in reinforced concrete) will be constructed for holding ships of 30,000, 16,000 and 13,000 tons, respectively.

Harbor Work Planned.—Three plans have been presented to the government of Barbados for harbor improvements by an expert who recently visited the colony for that purpose. The expenditure involved reaches from £40,000 ($140,000 at the present rate of exchange) to £200,000 ($700,000). Wharfage for sailing vessels and basins for lighters are the chief requirements. It is reported that the authorities favor the £200,000 plan.

Barges to Be Converted into Tankers.—Five barges, each 240 feet long, which were bought from the government by an English firm, have been brought from the Rhine to Leith and are being converted into oil tankers by Messrs. Henry Robb, Ltd., England. These barges will carry from 1,000 to 1,500 tons of oil and are to be used for supplying oil to oil-burning ships on the Thames. The work will require three or four months for completion.

Zanzibar Harbor Improvements.—The improvement works for Zanzibar harbor, East Africa, will cost, according to original estimates, £250,000 (or approximately $875,000 at the present rate of exchange). The scheme includes the reclamation of about 20 acres of land on Malindi Spit, near town. A concrete wharf, 1,300 feet in length, and a minimum low tide depth of water of 30 feet are included in the plans, and it is intended to install modern equipment of all kinds, including electric cranes.

Contract Awards.—According to the Danzig Journal, Der Osten, the Danziger Werft has been awarded a contract for reconditioning the four ex-German merchant vessels, which under the terms of the Peace Treaty are to be repaired by Germany. These vessels, which during the war were lying in South American harbors, are now being brought to Danzig from there. Three of the vessels have a displacement of 8,000 tons and one is of 18,000 tons. It is expected that work will start on them immediately.

New Steamer.—The steamer Vanellus, recently completed by Swan-Hunter & Wigham, Richardson, Ltd., at their Southwick shipyards, Sunderland, to the order of the Cork Steamship Company, Ltd., of London, and which is intended for the service carried on by that company between Manchester, Liverpool and Dutch and Belgian ports, has been turned over to her owners after a successful trial trip. The steamer is 290 feet long and is designed to carry over 3,100 tons deadweight on a light draft of water.

Lloyd's Figures.—According to returns compiled by Lloyd's Register, which take into account only vessels of 100 tons gross and upwards, there were 921 merchant vessels of

3,708,916 gross tons under construction in the United Kingdom at the close of the three months ended December 31, 1920. In September, 1920, the corresponding figures were 961 vessels of 3,731,098 gross tons. The present figures include sixty-four steamers and motor vessels of 422,553 gross tons, which are intended to carry oil in bulk.

Largest Argentine Merchant Ship.—A vessel, which will be the largest ocean-going merchant steamer owned in the Argentine Republic, is being built by the Ailsa Shipbuilding Company, Ltd., at Troon, for the Sociedad Anonima Importadora y Exportadora de la Patagonia. This vessel will be named Jose Mendenez in honor of the company's first president. She will be 345 feet in length and have a speed of 14 knots. Accommodations will be provided for 200 first-class and over 300 third-class passengers. The vessel is intended for service between Buenos Aires and Patagonia.

Cunard Company Active.—The Cunard Company proposes to build twenty-three new vessels this year, giving a total tonnage of over 300,000. These vessels are to be smaller and swifter than those already owned by that company, and six of the new liners will be of 15,000 tons. The firms who have secured these contracts are Vickers, Ltd., of Barrow-in-Furness; Swan, Hunter & Wigham Richardson, Ltd., of Wallsend-on-Tyne; William Beardmore & Sons, Ltd., of Glasgow; John Brown & Company, Ltd., of Glasgow; Cammell, Laird & Company, Ltd., of Birkenhead; Armstrong, Whitworth & Company, Ltd., of Elswick, and Hawthorne, Leslie & Company, Ltd., of Jarrow-on-Tyne.

New Shipyard.—The new shipyard of the Societe Normande de Construction Navales at Harfleur, France, is nearing completion. This yard is on the north side of the Tancarville Dock and consists of three building berths of 7,000 tons capacity and a launching basin, and a fourth berth is under construction, to be finished later in the year. The company has contracts for eleven ships, eight of which have been ordered by the Bureau National des Charbons, and are to be of 6,500 tons each, while the remaining three will be of 6,800 tons each. The Societe Navale de l'Ouest have placed an order with the Chantiers Navales Francais for an oil tanker of 11,000 tons to be propelled by turbines of 3,000 horsepower, and it is expected that the construction of this vessel will begin immediately.

Colonial Program.—A program which would involve an outlay of 3,000,000,000 francs—2,000,000,000 for railroads, 400,000,000 for ports, and 400,000,000 for improving other waterways and irrigation, 150,000,000 for medical service and 10,000,000 for wireless installation—is suggested for development in the colonies, by M. Sarraut, minister to the colonies, according to advices received by the Bankers Trust Company of New York from its French information service. It is stated that twenty-five new French companies have been organized for development of France's colonial wealth, the capital of these companies ranging from 50,000 francs to 75,000,000 francs. Specific aims of the new corporations are general trade and exploitation of forests, fisheries, oil and cotton industries and improved navigation and transportation.

German Shipbuilding.—Some idea of extent to which German shipbuilding has revived may be gathered from the fact that in Hamburg yards alone there are twenty-eight vessels under construction at the present time, while in addition to these contracts have been placed for fourteen others. The Blohm & Voss yards have four steamers under construction for the Woermann Line, and seven for the Deutsch-Australische Dampfschiff Ges.; the Elbeschiffwerft has three vessels under construction; the Deutsche Werft is building sixteen vessels, two for Dutch account, six for the Hamburg-American Line, and eight for private account. The Reiherstieg Schiffswerft is building two vessels for the firm of A. Kirsten; the Vulkan works has two for the Deutsche Australische Dampfschiffahrts Ges., and three for the German Levant Line. The size of the vessels ranges between 5,000 and 10,000 tons.

TRADE PUBLICATIONS

Tube Cleaner and Soot Blower.—A pamphlet containing a short description of the "Superior" boiler tube cleaner and soot blower manufactured by the Superior Engineering Company, New York, has recently been issued.

Davidson Steam Pumps.—Marine pumps, condensers, ash ejectors, and evaporators are described in specification form in catalogue "B" issued by the M. T. Davidson Company, New York City. A special section is devoted to details of the Davidson improved valve motion for operation without lubrication in pumps under high steam pressure.

Oil Driving Compressors.—Bulletin No. 607 contains a description and various applications of oil-driven compressors manufactured by the Chicago Pneumatic Tool Company, Chicago, Ill. These machines are built in both stationary and portable types. The pamphlet also contains a comparison of the operating costs of oil and steam-driven compressors.

Rope Schedules.—Users of rope will find valuable data in the new all-manila rope schedules recently prepared by the Whitlock Cordage Company, New York. The schedules are mounted in convenient form for reference use. The same information, together with a complete illustrated story of Whitlock products, is contained in a catalogue issued with the schedule cards.

Development of Electricity in the Marine Field.—A booklet recently published by the Cutler Hammer Manufacturing Company, Milwaukee, Wis., tells in brief the story of the evolution of the engine-propelled ship. The requirements peculiar to electric control of ships are discussed and a description of eletcric control of auxiliaries on the motorship "Solitaire" is given.

R. & D. System for Bunker Oil.—A general description of the Row & Davis, Engineers, Inc., New York, system for handling bunker oil from storage in the inner bottom tanks of a vessel is contained in a catalogue issued by this company. The system applies forced circulation to the bunker oil, reliquidizes all the oil in the bunkers and preserves the full fuel value of the oil. An outline of the operating costs of the system is also given.

C-H Brakes.—Electrically operated brakes are described and illustrated in a booklet published by the Cutler Hammer Manufacturing Company, Milwaukee, Wis.. The booklet discusses shoe brakes for both direct and alternating current service. Tables of dimensions and ratings for each type of brake are given as well as an explanation of the calculations for determining the correct size of brake for any installation. Illustrations are shown of brakes applied to cranes, hoists, elevators and other machines.

Submarine Signalling.—The construction and operation of standard receiving apparatus of the Submarine Signal Company, Boston, Mass., for receiving signals transmitted through water are described in a bulletin published by this company. The system consists of receiving tanks filled with water or other suitable fluid placed inside a ship. The sounds coming through the water are picked up in the tank by microphones. The signal system utilizing the Fessenden oscillator for both sending and receiving under water signals is also fully described.

The Cooling of Quenching Oil in the Heat Treatment of Steel.—The Griscom-Russell Company, New York City, has published an illustrated booklet describing the necessity for heat treatment of steel, the various quenching mediums and systems commonly used, the advantages of continuous circulation of the medium and the adaptability of the multi-whirl cooler to the cooling of quenching oil. Typical installations showing the layout of the piping are given together with recommendations for the proper size and number of coolers to meet special requirements.

MARINE SOCIETIES

AMERICA

AMERICAN SOCIETY OF NAVAL ENGINEERS
Navy Department, Washington, D. C.
President—Capt. A. J. Hepburn, U. S. N.
Secretary-Treasurer—Commander J. S. Evans, U. S. N., Bureau of Engineering, Navy Department, Washington, D. C.
Annual meeting and election, first Tuesday in October, other meetings at call of the President.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS
29 West 39th Street, New York.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS
29 West 39th Street, New York City.

UNITED STATES NAVAL INSTITUTE
Naval Academy, Annapolis, Md.
President—Rear Admiral Bradley A. Fiske, U. S. N.
Secretary and Treasurer—Commander H. K. Hewitt, U. S. N.

NATIONAL ASSOCIATION OF MASTERS, MATES AND PILOTS
National President—John H. Pruett, 423 Forty-ninth St., Brooklyn, N. Y.
National Treasurer—A. B. Devlin, 187 Randolph Ave., Jersey City, N. J.
National Secretary—M. D. Tenniswood, 308 Vine St., Camden, N. J.

LIST OF OFFICERS, AMERICAN SOCIETY OF MARINE DRAFTSMEN
President—C. E. Deiser, 6124 Nassau Road, Philadelphia, Pa.
Vice-President—E. H. Monroe, 902 Virginia Ave., Washington, D. C.
Secretary—B. G. Barnes, 970 High St., Bath, Maine.
Treasurer—J. B. Sadler, P. O. Box 987, Norfolk, Va.
Executive Committeemen—G. W. Nusbaum, Washington, D. C.; A. H. Haag, Narberth, Pa.; John Thomson, Bethlehem, Pa.

NATIONAL MARINE ENGINEERS' BENEFICIAL ASSOCIATION OFFICERS
National President—Wm. S. Brown, 356 Ellicott Square Bldg., Buffalo, N. Y.
National Secretary-Treasurer—Geo. A. Grubb, 356 Ellicott Square Bldg., Buffalo, N. Y.

CANADA

GRAND COUNCIL, N. A. OF M. E. OF CANADA
Grand President—E. Read, Rooms 10-12, Jones Building, Vancouver, B. C.
Grand Vice-President—Jeffrey Roe, Levis, P. Q.
Grand Secretary-Treasurer—Neil J. Morrison, Box 886, St. John, N. B.
Grand Conductor—E. A. House, Box 333, Midland, Ont.
Grand Door Keeper—Lemuel Winchester, 306 Fitzroy Street, Charlottetown, P. E. I.

GREAT BRITAIN

INSTITUTION OF NAVAL ARCHITECTS
5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND
39 Elmbank Crescent, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS
Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORPORATED
The Minories, Tower Hill, London.

ITALY

COLLEGIO DEGLI INGEGNERI NAVAL E MECCANICI IN ITALIA,
Via Carlo Alberto 18, Genova.

Marine Engineering

Volume XXVI APRIL, 1921 Number 4

LIBRARY
APR 7 1921
U. S. PATENT OFFICE

(*Photograph copyright by N. Moser, N. Y.*)

Fig. 1.—United States Battleship *Tennessee*, America's Latest Superdreadnought

Propelling Machinery of the U. S. S. Tennessee

Latest American Battleship Driven by Electricity Generated in Westinghouse Turbine Generators Delivering 40,000 Horsepower

SINCE the U. S. S. *Tennessee* is the first battleship to be designed specifically for steam-electric propulsion (the *New Mexico* having been originally intended for turbine drive), her propelling equipment is of special interest. The general arrangement of her machinery is as follows:

Each turbine generator unit with its exciters is located in a separate watertight compartment, and its condensers, pumps, air ejectors and other auxiliaries in a compartment below. The four propeller motors occupy three watertight compartments in the stern, the two inboard motors being in one, and an outboard motor in each of the other two. No other apparatus is in the motor compartments. The control room from which all of this machinery is controlled is also separate and watertight, and is aft of the turbines and forward of the two inboard motors.

Turbines

Each turbine generator unit consists of a single Westinghouse steam turbine directly connected to a 3-phase alternating current generator, rated at 15,000 KVA for continuous operation and delivering 3,400-volt, 36-cycle current, at full speed.

The turbines are of the impulse and reaction type, and permit the complete expansion of the steam in each cylinder. They are designed to take steam at 250 pounds gage pressure at the throttle, 50 degrees superheat, and 28½ inches vacuum. The steam, on entering the turbine, is first expanded in a set of nozzles, and then passes through a 2-row impulse wheel and through a high pressure reaction stage. It then divides, and the two parts pass through low pressure reaction blading on opposite ends of the rotor, and exhaust into the condenser.

The speed of the turbine can be varied over a range of from 1,500 to 2,200 revolutions per minute by means of a manually operated governor. This governor is of the centrifugal type, but instead of being loaded by means of a spring, it is loaded by hydraulic pressure, the fluid being oil. The pressure of this oil is regulated by a valve in the control room, so that the turbine speed can be controlled at will from this point. The speed of the turbine depends upon the setting of this valve and will remain constant for a given setting regardless of the load.

The turbine has also an overspeed governor which will automatically shut it down in case of excessive speed. This governor can be manually operated at the turbine or by a wire pull from the control room.

The main generators, which are of Westinghouse make, are similar in design and construction to those used on land, except that special precautions have been taken to protect the windings from salt and moisture. The insulation is of the best known materials and is applied by thoroughly tried methods. Each coil was insulated by the vacuum and pressure method and then given several treatments of varnish and baked after each treatment. On completion, the entire winding was varnished and baked.

Generators

Ventilating air is blown through the stator coils by means of blowers mounted on the rotors, which provide sufficient air to keep the windings cool, under any condition. The air is drawn in at the bottom of the end bell, is forced axially through the machine and is discharged radially through an opening in the top of the frame to ducts leading to the deck.

The rotor is of the totally closed type and is not ventilated internally. It is connected to the turbine by means of a flexible coupling which is enclosed in the bearing housing between the two machines.

The bearings of both the turbines and the generators are lubricated by oil under pressure from motor-driven rotary pumps. Should these pumps fail, similar pumps driven by steam turbines immediately start up automatically, so that no break will occur in the oil supply. Oil for the hydraulic governor is supplied from the same source.

Auxiliary Turbine Generators

In each engine room there are three 300-kilowatt direct current turbine-generators, which supply current for light, for operating the various motor driven auxiliary machines throughout the ship, and for exciting the generator fields.

The current for exciting the generator fields is automatically controlled by a small motor generator "booster" set in each engine room. The motor of this set is driven by power from the auxiliary turbine generators, and the generator of the set bucks or boosts the voltage of the field current to the value best suited to given operating conditions.

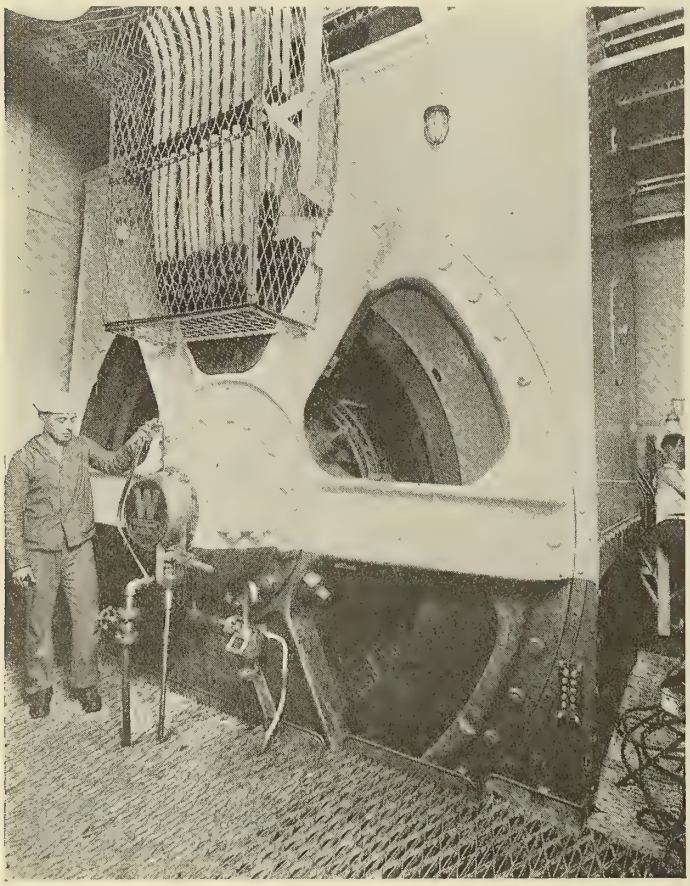


Fig. 2.—One of the Four 8,000-Horsepower Propeller Motors

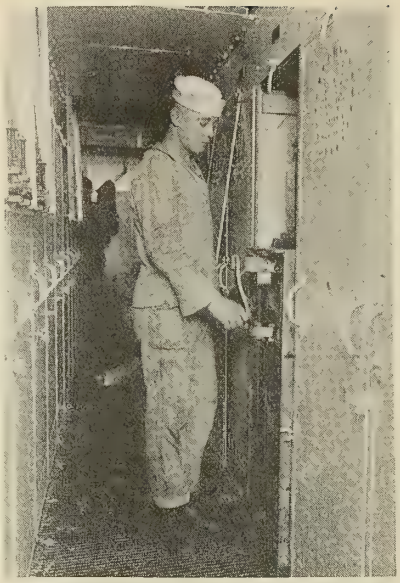


Fig. 3.—Main Switch Aisle

Pumps

The main and auxiliary condensate and circulating pumps, as well as the oil cooler circulating pumps, are motor driven. The vacuum is normally maintained by air ejectors, but as this is the first use of air ejectors for main condensers on a battleship, steam driven air pumps are also installed.

The four propeller motors are of the Westinghouse induction type, and each is rated at 8,375 horsepower at its maximum speed.

The Propeller Motors

In order to provide two speed ranges, each motor can be connected so as to provide either 24 or 36 poles. The primary, or stator, has two independent windings, one for each pole arrangement; while the secondary, or rotor, has a single winding, with cross connections, which forms a polar winding terminating in three slip rings with the 24-pole arrangement, and a squirrel cage winding with the 36-pole arrangement.

The motors are operated at their lowest speed by connecting them for 36 poles and supplying them with power from the main generators operated at their lowest speed, so that for a ship speed of 10 knots, the motor speed is 78 revolutions per minute, and the generator speed is 1,430 revolutions per minute. To increase this speed the speed of the generators is increased, and at the maximum generator speed the motor speed is 118 revolutions per minute and the ship speed 15 knots. To still further increase the ship speed, the motors are connected for their 24-pole winding, and by again varying the generator speed, a range of motor speeds of from 118 to 180 revolutions per minute is obtained, and the speed of the ship is increased from 15 knots to maximum. One turbine generator gives sufficient power up to about 17 knots, while above that speed both are required. This arrangement gives a wide speed range, and at the same time makes it possible to obtain efficient operation of the turbines for both low cruising speeds and full speeds.

The construction of the motors follows standard land practice, with special insulation similar to that of the generator windings. The frames are of the self-contained type, with bearings supported by brackets, and the whole weight of 130,000 pounds is borne by feet cast integral with the frame. The bearings and bearing housings are readily adjustable by means of jack screws in the brackets, and are lubricated by oil under pressure.

The motors are ventilated by means of duplicate motor driven exhaust blowers mounted on top of each motor. Each blower has a capacity of 12,500 cubic feet of air a minute, and draws air through the cores and windings, and discharges it into ducts to the deck. These blowers are assisted by fan vanes on the rotors of the main motors, which can supply sufficient air to permit the motors to be operated at full load for short periods even if the exhaust blowers fail.

A small direct current motor is geared through a clutch

Fig. 4.—One of the Two Main Engine Rooms, Showing 20,000-Horsepower Turbine Generator

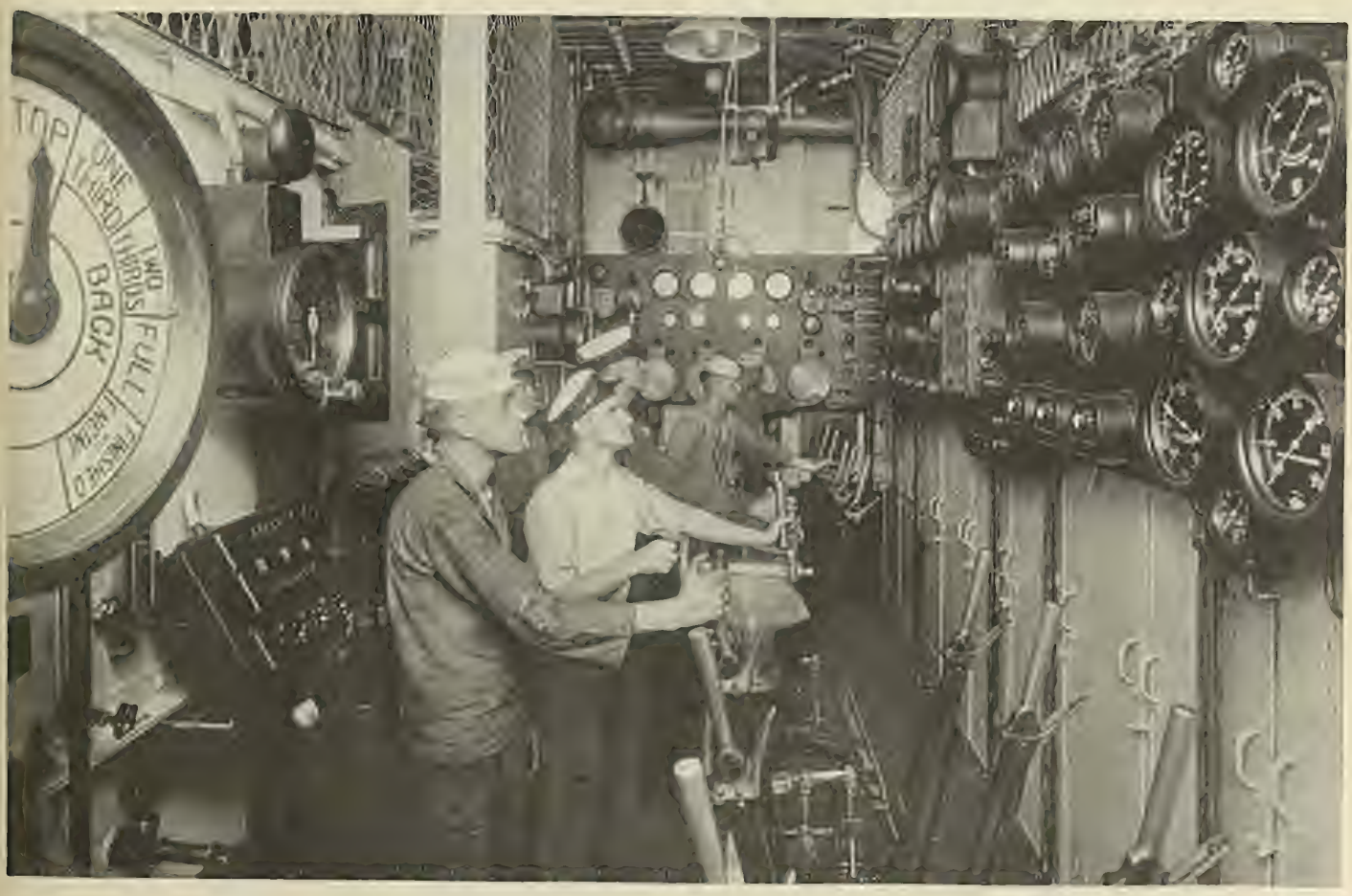


Fig. 5.—Control Room, Located in Center of Ship and Well Protected From Shells and Torpedoes, Where the Entire Control of the Vessel is Centered

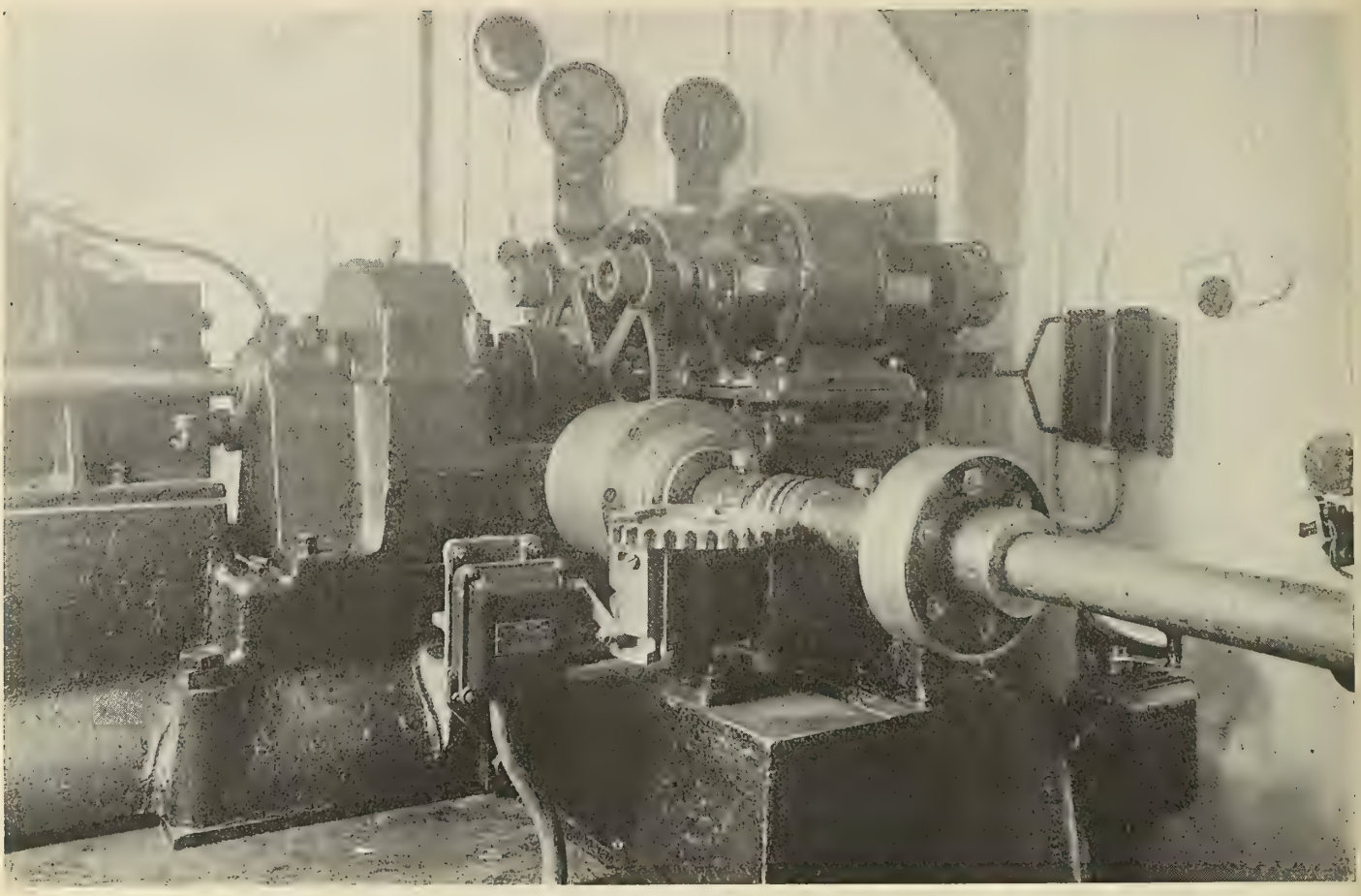


Fig. 6.—Steering Gear and Control Mechanism

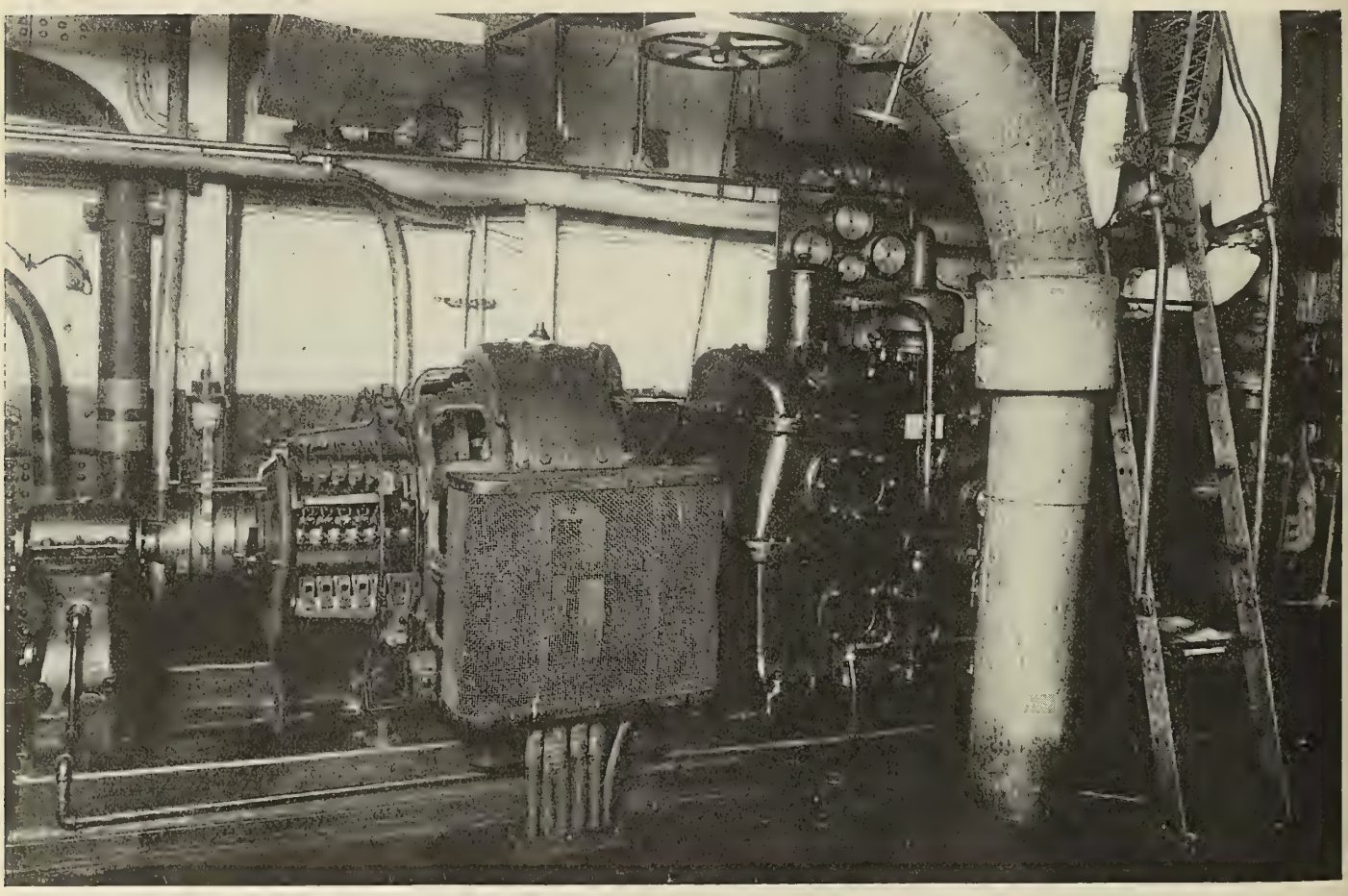


Fig. 7.—One of the Six 300-Kilowatt Direct-Current Turbine Generators That Furnish Light and Power Throughout the Ship

to each propeller shaft and is used to turn the motor rotor and the propeller slowly for inspection or repair.

The Control Room

All of the apparatus necessary for controlling the propelling machinery is located in the control room. The switches are mechanically operated by means of levers, which are arranged in a row down the center of the room. All of these levers are mechanically interlocked so that it is impossible to close or open wrong switches. Facing these levers, in plain sight of the operators, is a set of meters giving full information as to the operation of the machinery and the condition of the various circuits.

All of the switches handling the main high-voltage current are of the oil break type and are capable of being opened safely under full load and voltage, although normally they will not be so opened. The majority of the switches are located in a structure in front of the control board, where they are fully safeguarded with covers but are easily accessible. A special device has been built by means of which the oil tanks of the switches can be easily lowered so as to expose the contacts. A system of electrical interlocks and disconnecting devices protects the men against possibility of faulty operation, and also makes it possible to render safe for inspection the circuits of any one or two motors while the others are in operation.

The rheostats, used in bringing the motors up to speed when their 24-pole windings are in use, are of the liquid type and are located in the control room behind the control levers. In this type of rheostat, the resistance of the circuit is varied by raising or lowering the level of a solution of sodium carbonate in which electrodes, connected with the leads from the motor secondary circuits, are immersed.

The switches are arranged so that either generator can operate any or all of the motors, and so that the port and the starboard motors can be run in opposite directions, if desired. When both generators are used, each drives two motors, and the two systems are independent.

All of the main turbines, generators, motors, and control equipment, the auxiliary turbo generators, air ejectors, circulating and condensate pumps, and the motors for operating the steering gear and deck winches were manufactured by the Westinghouse Electric & Manufacturing Company.

Submarine S-48 Launched at Bridgeport

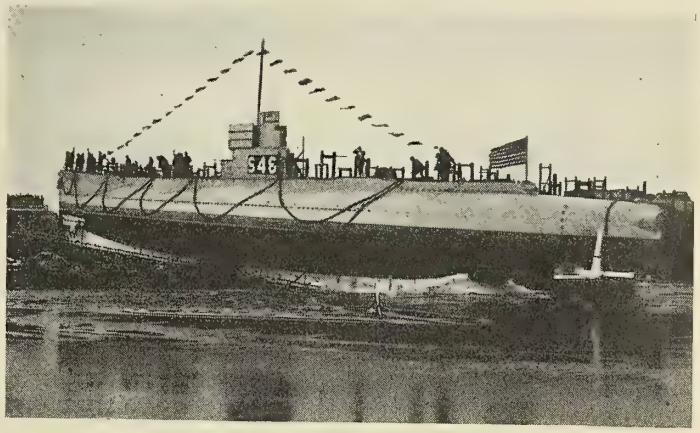
The submarine *S*-48 was launched at the yard of the Lake Torpedo Boat Company at Bridgeport, Conn., on February 26. The vessel was christened by Princess Tocoomwas, a lineal descendent of Uncas I of the Mohican tribe of Indians, in full Indian regalia. After the launching, the Princess and her party were presented with a miniature submarine by P. B. Brill, general manager of the Lake Torpedo Boat Company.

The *S*-48 is the first of a group of ten vessels, the design of which embodies the latest developments in submarine construction and, as a result of a delay in awarding the contract until 1919, it contains many improvements over the original "*S*" type. In order to accommodate the new features the length and displacement of the vessel were increased over the original design. The principal dimensions are as follows:

Length overall	250 feet
Breadth, maximum	22 feet
Draft, in normal surface condition	13 feet 6 inches

She has a displacement of 993 tons; has the double hull type of construction for one-half length amidships; the forward and after hull portions being of single hull type and the vessel is designed to submerge to a depth of 200 feet with safety.

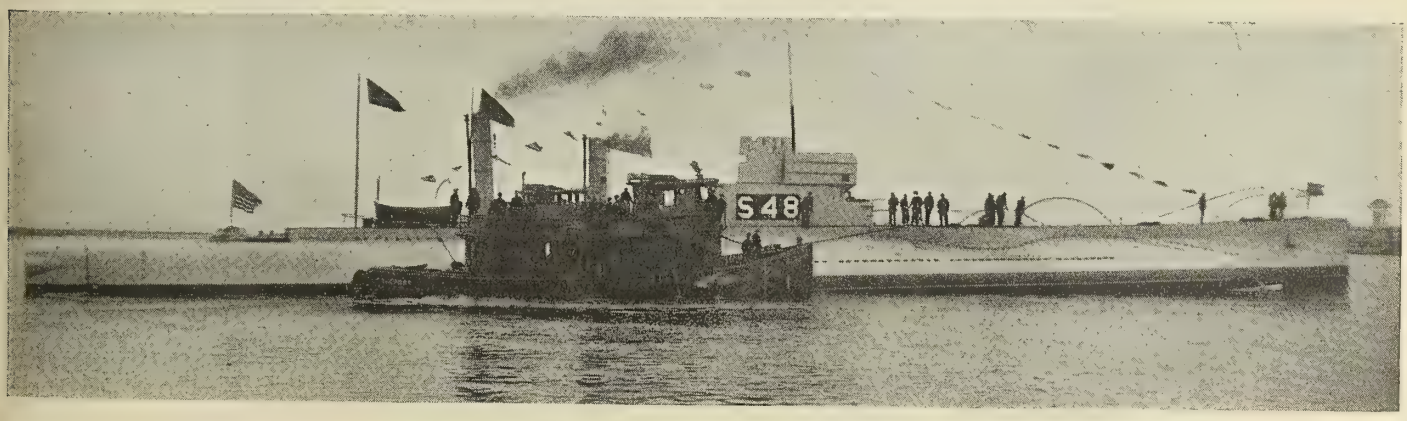
Four 21-inch torpedo tubes are installed in the bow and one 21-inch torpedo tube in the stern. A four-inch, fifty-caliber gun will be located on the deck forward of the conning tower, a special hatch being fitted to provide access for the gun crew to reach the gun. Three periscopes will be fitted, one of which has its eye piece in the conning tower and is arranged with a platform which rides up and down with the periscope.



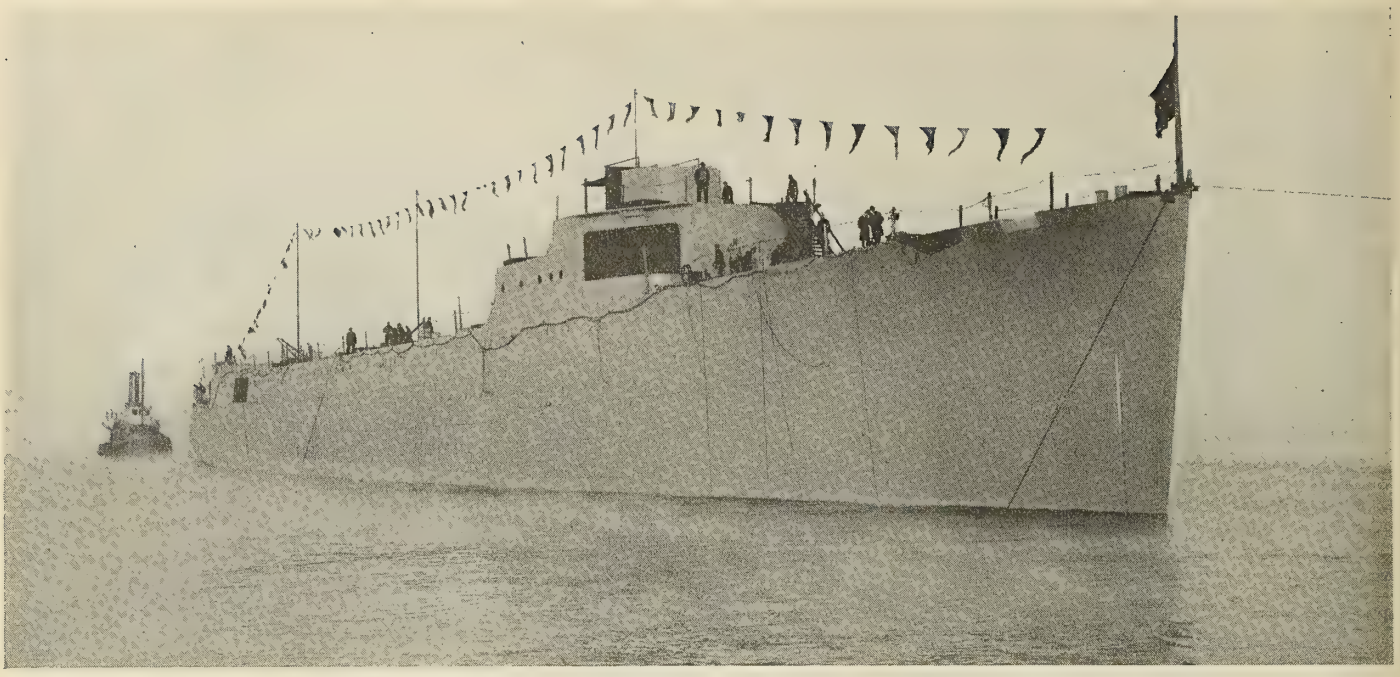
The *S*-48 Going Down the Ways

The vessel will be propelled on the surface by two Diesel engines of 950 brake horsepower. The vessel has twin screws, each engine driving its own propeller. When the vessel is submerged propulsion is obtained by two powerful electric motors.

A submersible radio apparatus is to be fitted which is designed to work when the vessel is submerged or running on the surface. Submarine coils will be installed for receiving radio messages when submerged.



United States Submarine *S*-48 Afloat After Launching



Scout Cruiser *Omaha*, Starboard Bow, After Launching, December 14, 1920

Our New Scout Cruisers

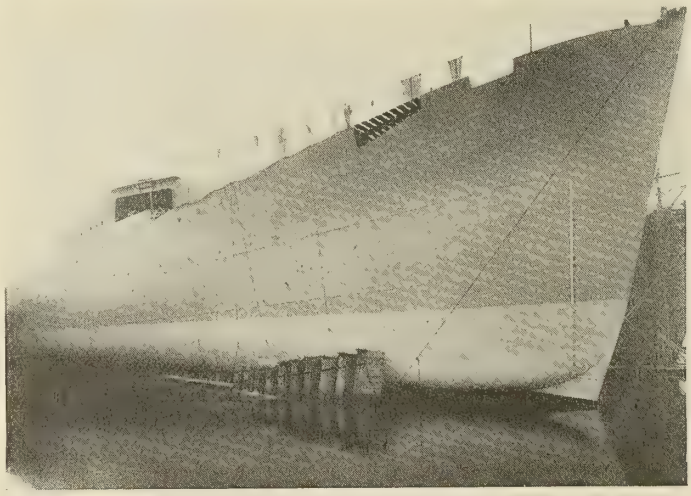
BY LIEUTENANT COMMANDER D. F. DUCEY, U. S. N.

In December of last year, there were launched at the Tacoma plant of the Todd Dry Dock and Construction Corporation the first two of ten light cruisers building for the United States Navy. These were the Omaha and Cincinnati; the other eight are the Milwaukee, Raleigh, Detroit, Richmond, Concord, Trenton, Marblehead and Memphis. One of the latter is building at Tacoma, two are under construction at the Fore River Plant of the Bethlehem Shipbuilding Corporation, Ltd., and five at the Philadelphia yard of Wm. Cramp & Sons Ship & Engine Building Company.

WHILE the hull construction and armament of our new scout cruisers embody many features that are new and undoubtedly of much interest, the purpose of this article is to deal primarily with the main propelling units installed within the machinery spaces, only such mention being made of auxiliary units, as ice machines, etc., as will lead to a clearer understanding of the layout in general.

These vessels, displacing 7,100 tons, have an overall length of 555 feet, on extreme breadth of 55 feet 4 inches and a mean draft of 13 feet 6 inches. At full power, a speed of 35 knots with a corresponding horsepower of 90,000 is expected. This 90,000 horsepower is divided among four shafts, each shaft being driven through gearing by a combination of turbines that provides the requisite speeds ahead and astern in the most economical manner.

The main turbines with their necessary auxiliaries are located in two watertight compartments. The necessary steam is supplied by twelve express type boilers located in four watertight compartments. These boilers are fitted for the use of fuel oil only. The boiler auxiliaries, with the exception of the main feed pumps, are located in the firerooms.



Scout Cruiser *Omaha* Launching Cradle, Starboard Bow

Machinery Arrangement

The general arrangement of engineer compartments, from forward aft, is as follows: Number one fireroom, number two fireroom, number one engine room, number three fireroom, number four fireroom and number two engine room. The two outboard propellers are driven from number one engine room and the two inboard shafts from number two engine room.

The main units of the individual vessels, while generally alike in arrangement, differ in details, the units being supplied by different firms. The vessels building at Tacoma will be equipped with Westinghouse turbines and Westinghouse gears; the Cramp vessels with Parsons turbines and DeLaval gears; and the Fore River vessels with Curtis turbines and Falk gears.

The Westinghouse ar-

rangement consists of four 22,500 horsepower cross compound Westinghouse turbines, the high and the low pressure elements being in separate casings; the low pressure casing contains the backing turbine, the cruising turbines are separate. A detailed description of these units having been published in the February issue of Marine Engineering, page 121, further details are omitted.

The Cramp installation consists of the usual Parsons combination, one high pressure turbine and one low pressure turbine connected through gearing to each shaft. The astern turbine is carried in the low pressure casing. There are two cruising turbines connected through gearing to one port and one starboard shaft. The shafts of the cruising gear wheels are fitted with power clutches. When operating on the cruising combination, a speed of over 15 knots is required. For cruising speeds, steam is admitted into the cruising turbine and thence through the cruising stages of the high pressure turbines in the same compartment. The cruising and high pressure turbines are direct flow, while the low pressure turbines are of the double flow type.

The new scout cruisers, with their tremendous horsepower, their high speed and sea keeping qualities, represent a type unique in the floating world. And when it is considered that in these 7,100-ton hulls, drawing less than fourteen feet of water, there is contained machinery that will develop over 90,000 horsepower, a power equal to that of four modern destroyers, one familiar with modern ship construction can well understand the difficulties met with in construction.

The Fore River installation is similar to that adopted for destroyers and consists of Curtis turbines, one high and one intermediate pressure turbine in series and one double flow low pressure turbine connected by gearing to each main shaft. As in the other installations, the astern turbine is in the same casing as the low pressure turbine; there are no cruising turbines. In order to obtain the equivalent economy that would exist were cruising turbines installed, recourse is had to fitting special nozzles on the steam chests of the high pressure turbines.

Bearings

In all types of turbines installed necessary connections for utilizing the excess auxiliary exhaust are installed, as likewise the latest and most approved methods for checking and adjusting clearances.

The unbalanced steam thrust of the turbines will be taken by thrust bearings of the pivoted segmental Kingsbury type. The propeller thrust will be taken by similar bearings located at the ends of the main reduction gear casings. The spring bearings are of the self-alining, self-oiling, water cooled type. The thrust bearings and main bearings will be lubricated under pressure.

Propellers

The propellers, which will be cast solid, are approximately eleven feet in diameter, with a pitch of twelve feet and a projected area ratio of 0.60. At full power, they will make about four hundred revolutions.

Reduction Gearing

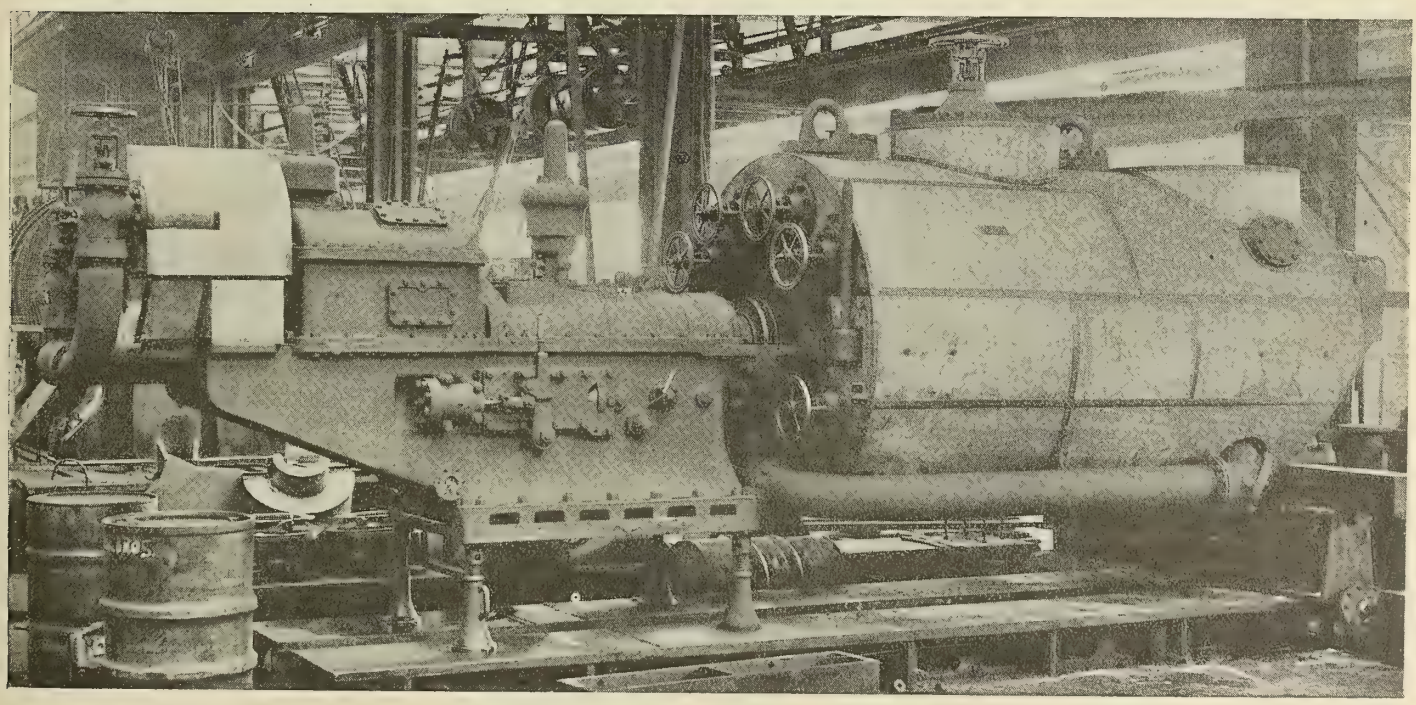
The speed reduction gears, which are the largest yet installed in our service, are of the toothed gear type, the two driving pinions on each unit meshing directly with the gears. The speed reduction ratio varies from 6.3 to 1 to 7 to 1 on the various types and is effected in a single step. Both pinions and gear wheels are of the double helical type, the pitch and teeth angles varying with the types. Where considered necessary, the teeth are thinned and chamfered.

Boilers

Five vessels have Yarrow and five (Cramps) have White Forster boilers, twelve to a vessel, with an aggregate heating surface of 90,000 square feet. The furnace volume is approximately 800 cubic feet and the working pressure 265 pounds gage. The boilers are equipped for burning fuel oil only and are capable of supplying an excess of steam.

Fuel Oil Burning Apparatus

The fuel oil burning apparatus for the Bethlehem vessels will be of the Bethlehem type, nine registers, complete with atomizers, to a boiler. These nine registers are capable of burning approximately eleven thousand pounds of oil per hour. The Cramp vessels will be fitted with Bureau of Engineering type forced draft registers and atomizers, fourteen registers to a boiler. The Todd vessels will be equipped



One of the Main Propelling Units of the *Omaha*

with the Babcock and Wilcox "Lodi" type register and atomizer, six to a boiler, each register being capable of burning two thousand pounds of oil per hour.

This last mentioned atomizing apparatus is at least three times the capacity of any yet used on board ship and is the forerunner of what is hoped to be a development of considerable importance in the fuel oil burning field. Some idea of the capacity of these registers may be obtained when it is considered that one of them will burn in one hour the equivalent of the amount of coal a house owner uses in a month.

Air Supply

In order to supply air to support the existing high rates of combustion, twelve turbine driven forced draft blowers are installed in each vessel. The closed fireroom system will be used, three blowers to a fireroom. Each blower will be capable of supplying fifty thousand cubic feet of air at a pressure of seven and one-half inches of water. The steam consumption of these twelve blowers will amount to over seventy thousand pounds per hour.

Fuel Oil Stowage

The fuel (only oil will be carried) will be stored in tanks located forward and aft of the engineer compartments. Provision is made for fueling both in port and at sea and for supplying smaller craft. Each tank is fitted with heating coils, suction and discharge piping and drains, and the whole is so piped that any tank can be used as a supply to any boiler. Tank clinometers, air vents and other safety apparatus will be installed.

Condenser and Vacuum Apparatus

Each combination of main units will have its own main condenser, each condenser having a cooling surface of approximately eleven thousand square feet. These condensers will be connected directly, via the exhaust trunks, to the main low pressure units, other connections being made as necessary for the auxiliary exhaust and drain lines, etc.

The circulating water for each condenser is supplied by a steam driven, water balanced centrifugal pump having a capacity of eleven thousand gallons per minute. For high speeds, scoops are fitted, the pumps being used only in port and when maneuvering.

To maintain the required vacuum of about twenty-nine inches, air ejectors, air separators and turbine driven centrifugal condensate pumps, with a capacity of five hundred thousand pounds of condensate per hour at a head of sixty-five feet, will be fitted. Each unit is duplicated and so interconnected as to permit of it being used on either condenser in any one engine room. Five of the vessels will be so fitted and the other five will be equipped with the ordinary type air pumps and augmentors (the Parsons system).

There will be two auxiliary condensers, one in each engine room, each having a cooling surface of one thousand square feet. These are capable of handling the exhaust in port. The air pump is of the single cylinder double acting type, and the circulating pump of the centrifugal type.

Pumps

Each vessel will be equipped with four main feed pumps; these pumps will be in the engine rooms and will ordinarily supply water to the boilers. They will be of the centrifugal type, turbine driven, having a capacity of six hundred gallons per minute at three hundred and ninety-eight pounds discharge head. As a standby, and when it is not necessary to use these pumps, four reciprocating auxiliary feed pumps are provided in the firerooms.

Adequate pumps for the drainage of the various compartments, the handling of fresh water and for use in connection with the distilling plant and ice machines are provided.

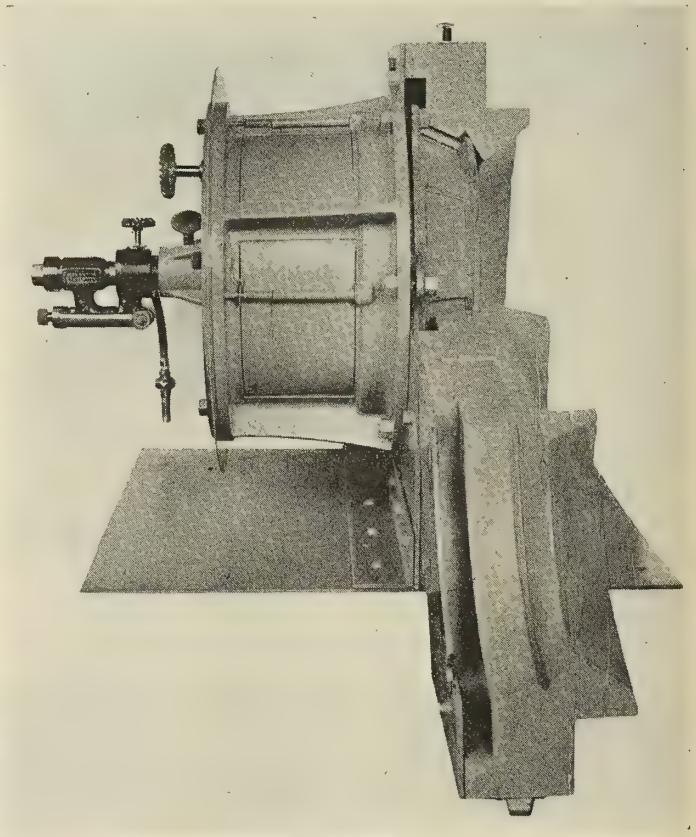
Lubrication

Lubrication of the main units is provided for by eight reciprocating pumps. As the closed system is used, the oil is supplied under pressure. Oil coolers, strainers and regulating valves are provided to insure a proper distribution of the oil at the requisite temperatures. The systems are provided with automatic alarms that operate when the oil pressure falls below a predetermined setting.

Distilling Plant

The evaporators, distilling condensers and attendant auxiliaries are located in a separate compartment outside the engine room spaces. There will be four evaporators of the submerged coil type, seven vessels having the Reilly type and three vessels having the Schutte-Koerting type. The feed heaters and distilling condensers will be of a corresponding type.

These evaporators will have a capacity of twenty-five thousand gallons per day and can be operated in either single



Type of Oil-Burning Apparatus Used on the *Omaha*

or double effect. They will provide sufficient water supply to the boilers for steaming purposes, and drinking and washing water for the crew.

Ice Machines

In the same compartment with the evaporators will be two 2-ton ice machines. These will provide refrigeration for the cold storage rooms, where the fresh meats and vegetables are carried, will cool the drinking water in the scuttle-butts and will be connected up for freezing ice cream in such quantity that all the crew can be supplied at one time.

The ice making cabinets have a capacity of five hundred pounds a day. Five vessels will have Johns-Manville Audiffren-Singrum machines, and five vessels will be equipped with Clothel machines.

Generators

On five vessels there are installed in each machinery space, on a dynamo flat, one 100 kilowatt and one 50 kilowatt, 125

volt direct current, turbo-generator sets. The 100-kilowatt units consist of a three-stage horizontal Curtis steam turbine running at approximately 3,600 revolutions per minute, at rated capacity, driving a General Electric Company compound wound generator running at 1,200 revolutions per minute, through a Poole turbo three to one reduction gearing; the three units being mounted on a common bedplate. The 50-kilowatt units consist of a two-stage horizontal Curtis steam turbine running at approximately 3,600 revolutions per minute, and direct connected to a General Electric compound wound generator; both units mounted on a common bedplate.

The turbines of both units are designed to operate under normal steam conditions of 250 pounds gage, with maximum steam conditions of 275 pounds gage and to normally exhaust against 25 inches vacuum. When operating non-condensing, they are to exhaust against a maximum pressure of 10 pounds gage.

The machines for the other five vessels will be similarly constructed, but of Westinghouse design.

Workshop

That the vessels may be self-sustaining as regards repairs, a roomy and well-lighted workshop, fully equipped, is provided. This is located clear of the machinery spaces in order to facilitate the handling of work. The workshop will be provided with the following machine tools:

One motor driven, screw cutting, extension gap lathe, seven feet between centers, with motor of the variable speed type and connected by means of gears; one motor driven tool room lathe, four feet between centers; one motor driven column tool-room shaper with a fifteen inch stroke; one upright drill, motor driven, to drill up to one and one-half inches diameter and having twelve inches traverse of spindle; one universal milling machine with an eighteen inch longitudinal feed of table, thirteen inch vertical movement, and eight inch traverse; one two-wheel emery grinder; and three machinist's swivel bottom vises.

In addition to the above, there is all the electric motor driven machinery, such as steering gear, galley appliances, such as potato peelers, dish washing machines, dough-mixing machines, meat and food grinders, and cake machines, that are common to all modern vessels of war.

In ordinary construction perhaps it would be no great feat to install the necessary machinery within such a small space. But with the duplication of units and the protection and sectionalizing required for military reasons, to properly locate the various units and arrange the piping systems so that each and every unit is readily available for overhaul, represents no small task, especially when it is considered that the total weight of machinery will not be far in excess of 1,600 tons.

An Entirely Electrically Welded Vessel*

A RATHER remarkable incident was witnessed on December 29 last at the works of Elektriska Svetsnings Aktiebolaget, Gothenburg, Marieholm, when the first entirely welded ship built in Sweden for practical use, and the second on the European Continent, was launched. The vessel is being built for the above named company's own account and is intended to be a self-propelling electrically welded vessel with arrangement for towing.

The boat is specially constructed for its purpose by Professor A. H. Lindfors. It has a flat bottom, which extends at both ends right up to the waterline, but its appearance on the water does not differ much from our ordinary type of tugboats. The total length of the vessel is 52 feet 6 inches, the breadth 13 feet 1½ inches, the molded depth 7 feet and the draft 3 feet 6 inches.

The main part of the vessel is to be occupied by the machinery, which consists of semi-Diesel crude oil engines, intended to drive specially constructed generators for electric welding and also air-compressors. The boat is to be employed in the harbors and neighboring West Coast places in conjunction with the company's other boats for carrying out repairs to ships, whether in the harbor or in dry docks or at the respective shipbuilding yards.

The most interesting feature, however, is the absence of rivets which is noticeable at the first glance at the boat, and still more striking, when on board. Apart from the two rubbing bars, the sides as well as the bottom are smooth and glossy as if cast in one piece, which, in fact, due to the welding is practically the case. The same is true of the deck, hoods, beams, bulkheads and frames, the last named being connected with the plating even more strongly than demanded by Lloyd's Register for welded ships.

The boat is built under special survey of Lloyd's Register, Bureau Veritas, and the Swedish Government Inspection.

Self-Propelled Electrically Welded Vessel

The engine room skylight is the only part of the whole ship that is made removable, bolts have been used. Otherwise the vessel is welded throughout, having a total length of welds of 5,655 feet on different thicknesses of metal.

On the Continent the first entirely welded ship was built in 1919 by the licensees of the "Kjellberg" system in France, at the S. A. F. (La Soudure Autogene Francaise) in Paris. The vessel was built at Caen and is similar to the above named boat, and for the same purpose, although somewhat larger. It is stationed in the harbor of Le Havre.

It is assumed that the Swedish shipbuilding industry, with which Mr. Kjellberg is closely related, will take considerable advantage of the experience gained during the building of this boat.

* Translated from article appearing in *Goteborgs Handels och Sjofarts-Tidning*, December 31, 1920.

Naval Architects' Meeting in London

AT the annual meeting of the Institution of Naval Architects, held in London on March 16, 17 and 18, the following papers were read and discussed: "Notes on Some Features of German Warship Construction," by Sir Eustace D'Eyncourt, K. C. B.; "Ex-German Battleship *Baden*," by S. V. Goodall, M. B. E., R. C. N. C.; "The Strength of Submarine Vessels," by W. R. G. Whiting, M. B. E.; "Mechanical Gears of Double Reduction for Merchant Ships," by R. J. Walker, C. B. E., and S. S. Cook, B. A.; "Life-Saving Appliances on Cargo and Passenger Vessels," by E. W. Blocksidge; "The Design of Balanced Rudders of the Spade Type," by M. E. Denny, C. B. E., S. B.; "Standardization of Data for Airship Calculations," by H. B. Wyn Evans, R. C. N. C.; "A Study of the Framing of Ships," by Professor T. B. Abell, O. B. E., M. Eng.; "On the Spacing of Transverse Bulkheads," by K. G. Finlay; "Deflections of Bulkheads and of Ships," by A. M. Robb, B. Sc., and "Some Experiments on Tallows in their Use for the Launching of Ships," by J. J. King-Salter, R. C. N. C.

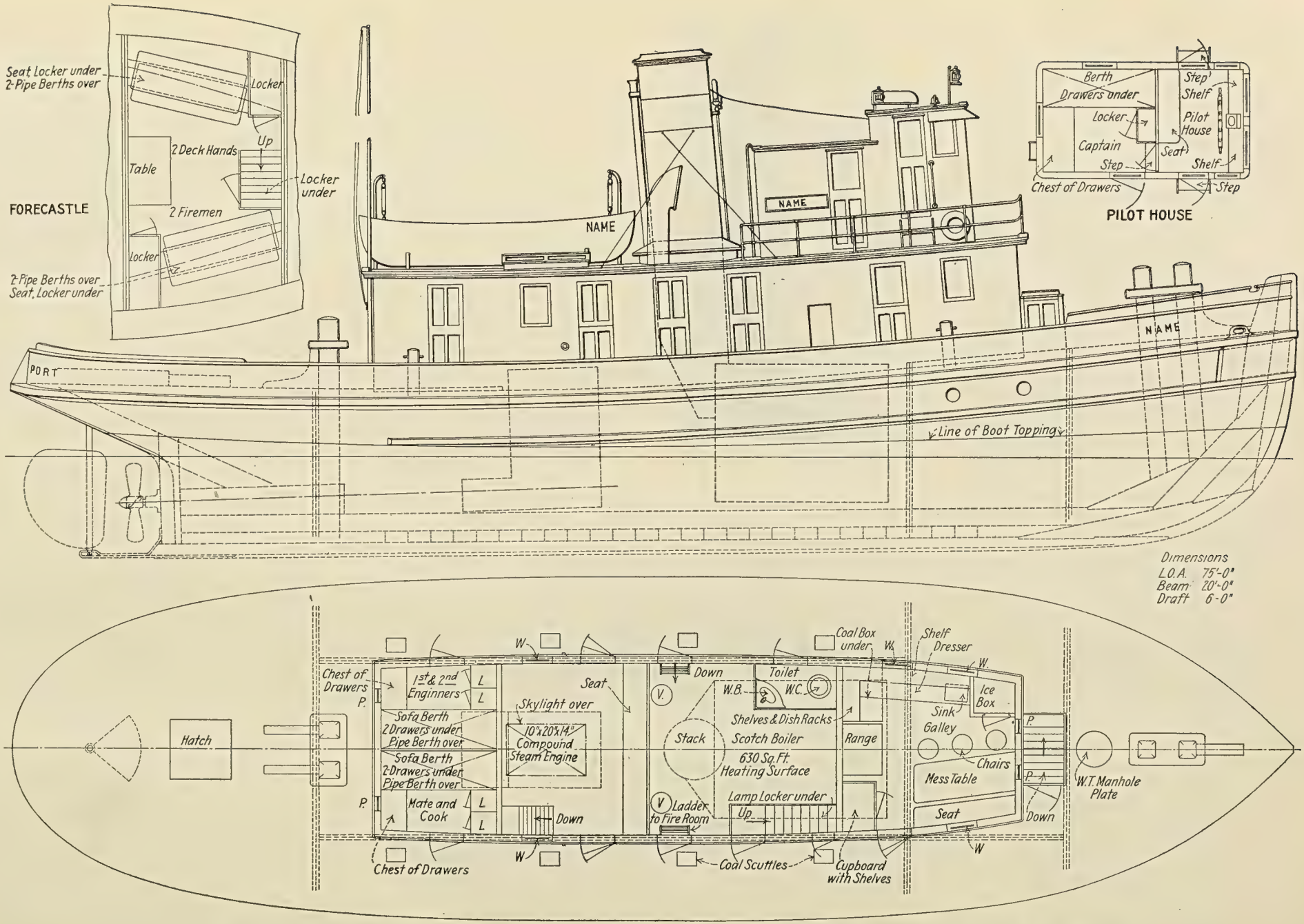


Fig. 1.—Profile and Main Deck of 75-Foot Wooden Tug Designed by Tams, Lemoine & Crane, New York, for Service in the Tropics

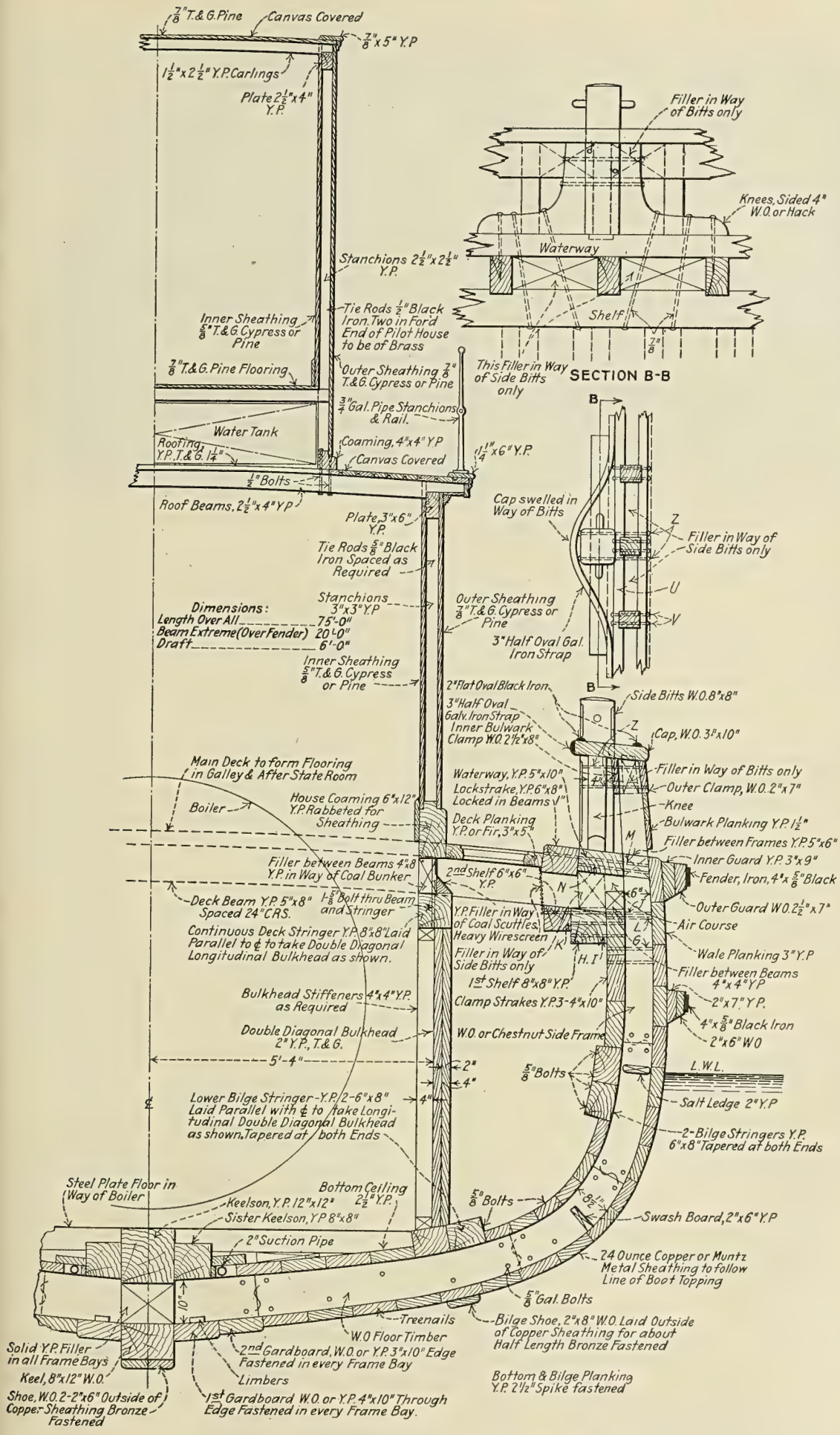


Fig. 2.—Midship Section of 75-Foot Wooden Tug

Wooden Tug for Service in Tropics

DESIGNS have been made by Tams, Lemoine & Crane, naval architects, 52 Pine street, New York City, for a wooden tug to be used for towing work in the waters about Cuba. She will be of heavy construction with the bottom coppered and was designed for classification by the American Bureau of Shipping.

The main propelling machinery will consist of a compound engine of about 150 indicated horsepower. Steam will be generated in a single boiler of the Scotch type fitted for coal burning. All fittings and auxiliaries necessary to the best economy will be installed, including an electric light plant of suitable size. A bunker capacity of 30 tons has been provided and arrangements made for carrying 10 tons of boiler feed water.

The harbor in which the tug is to operate has a depth of water of about 7 feet alongside the docks and for this reason the tug was designed for a maximum working draft of 6 feet.

The tug is 75 feet long overall with an extreme beam over the fenders of 20 feet. The framing is of white oak in short lengths, the side frames tapering from 8½ inches at the bilge to 6 inches at the main deck. The floor timbers are 10 inches deep at the keel. The keel is of white oak 8 inches by 12 inches and the main keelson of yellow pine 12 inches by 12 inches. The deck beams are of yellow pine 5 inches by 8 inches spaced 24 inches. The bilge stringers are of yellow pine.

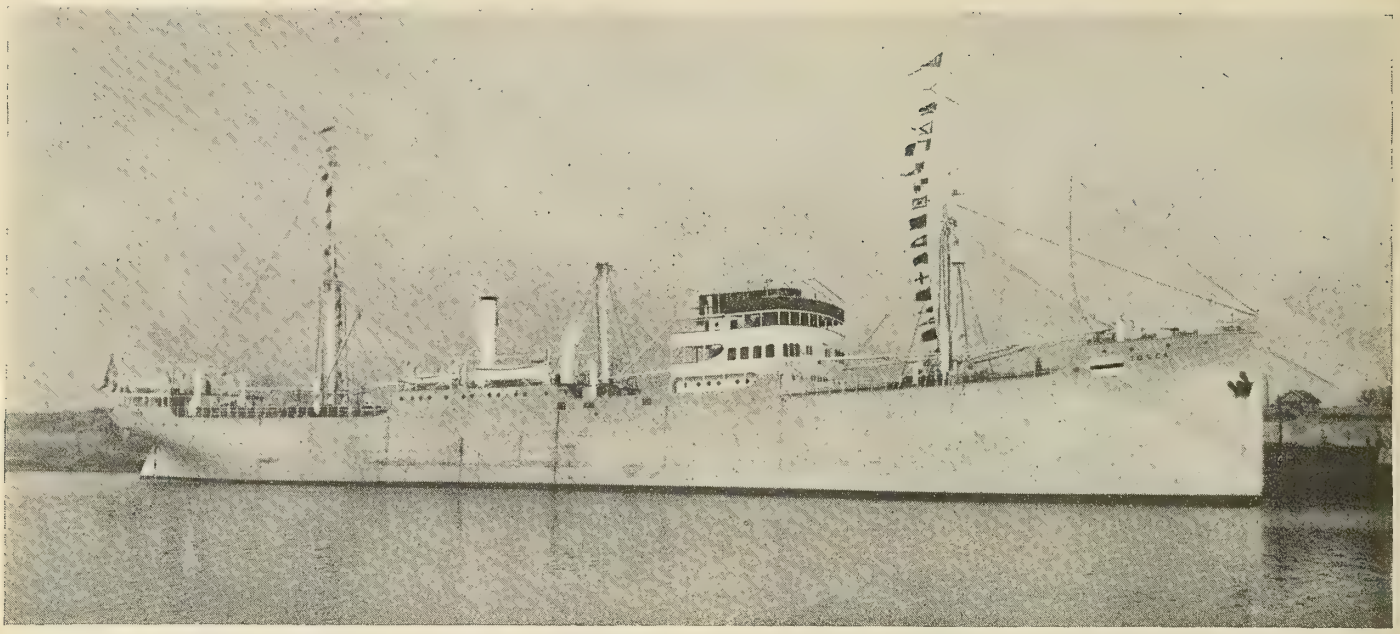


Fig. 1.—New 7,000-Ton Motorship *Tosca*, Owned by Winge & Company, Christiania. The First of Four Vessels for the Same Owners. Fitted With Two 1,400-Horsepower Werkspoor Oil Engines

Motorship Tosca

Description of a Modern Twin Screw Cargo Vessel Designed and Built in Norway

A RECENT addition to the growing list of motorships is the *Tosca,* which was built by the Nederlandsche Scheepsbouw Maatschappy of Amsterdam and engined by the Werkspoor Engine Works, also of Amsterdam.

The *Tosca,* which was built to the account of Winge & Company of Christiania, is of the following principal dimensions:

Length between perpendiculars	114.300 meters
Breadth	15.620 meters
Depth to main deck	7.770 meters
Depth to spar deck	10.360 meters
Draft loaded	7.342 meters
Deadweight capacity	6,990 tons
Displacement	10,260 tons
Speed, loaded	11 knots

The vessel was built in accordance with the rules of the Norske Veritas and to the Norwegian Law.

Accommodations

Passenger accommodation, consisting of six spacious two-person cabins and two saloons, provides for carrying twelve passengers. These are located in the bridge deck house and above are the captain's room, wheel house, chart house and Marconi station.

Deck officers and engineers are housed in a deck house erected about the engine room shaft and the crew accommodations are located in the poop.

Hull

The fore part of the vessel is specially reinforced to permit forcing its way through ice.

The hull contains two continuous decks. There are two pole masts, one kingpost, one funnel and five cargo hatches.

Steel corn bulkheads are provided on the centerline, forward and aft of the hatches, and arrangements made to allow wooden partitions being fitted between the steel bulkheads in such a way that a midship bulkhead is formed when carrying corn cargo.

A double bottom extends over a large part of the vessel's length and arrangements are made for carrying fuel oil or water ballast. The space between the shaft tunnels is fitted as an oil bunker and smaller bunkers are also fitted outboard of the tunnels. Fresh water is carried in three large tanks located 'tween decks amidships.

Main Propelling Machinery

The main propelling machinery consists of two, direct reversible, Werkspoor marine Diesel engines. Each engine has six cylinders 560 millimeters in diameter by 1,000 millimeters stroke and develops 1,400 indicated horsepower at 125 revolutions per minute. This provides a speed for the vessel of 11 knots at a fuel consumption of 9 tons per day.

Auxiliary Machinery

The auxiliary machinery consists of the following:

Three main electric generating sets, each consisting of a 50-kilowatt, 220-volt generator direct connected to a 2 cylinder, single acting, four cycle Werkspoor Diesel engine. The engine develops 100 horsepower at 250 revolutions per minute, each cylinder being 320 millimeters in diameter by 450 millimeters stroke.

An air compressor, to deliver air at a pressure of 1,000 pounds per square inch, direct connected to an electric motor of 90 kilowatts output at 275 revolutions per minute.

An electric driven, centrifugal, cooling water pump with a capacity of 150 tons per hour at 975 revolutions per minute.

An electric driven, centrifugal, ballast pump with a capacity of 150 tons per hour at 1,450 revolutions per minute. This pump may also be used as a stand-by for engine cooling and also for deck wash purposes.

An auxiliary oil motor generating set.

A spare lubricating oil pump combined with a spare bilge

Top of Mast in Lower Position

Portable

TOSCA

Bos'n Store

Store

Store

No 1 Hold

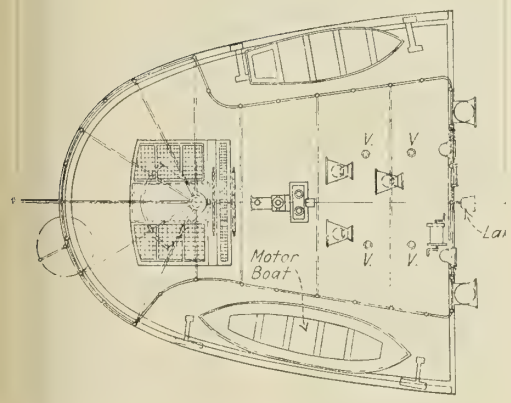
Ballast

Fresh Water

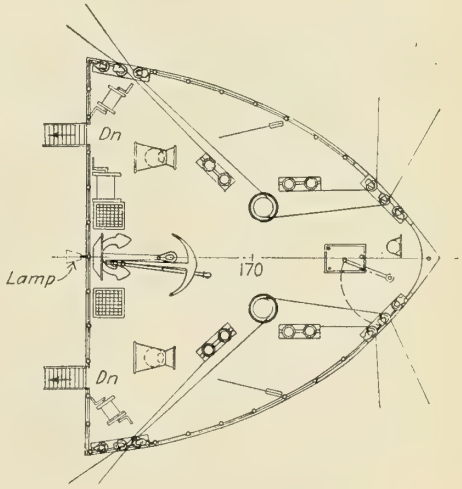
A.P. 10 130 140 150 160 170 175 F.P.

1-Tanker Ballast

1-Tank Oil or Water Ballast

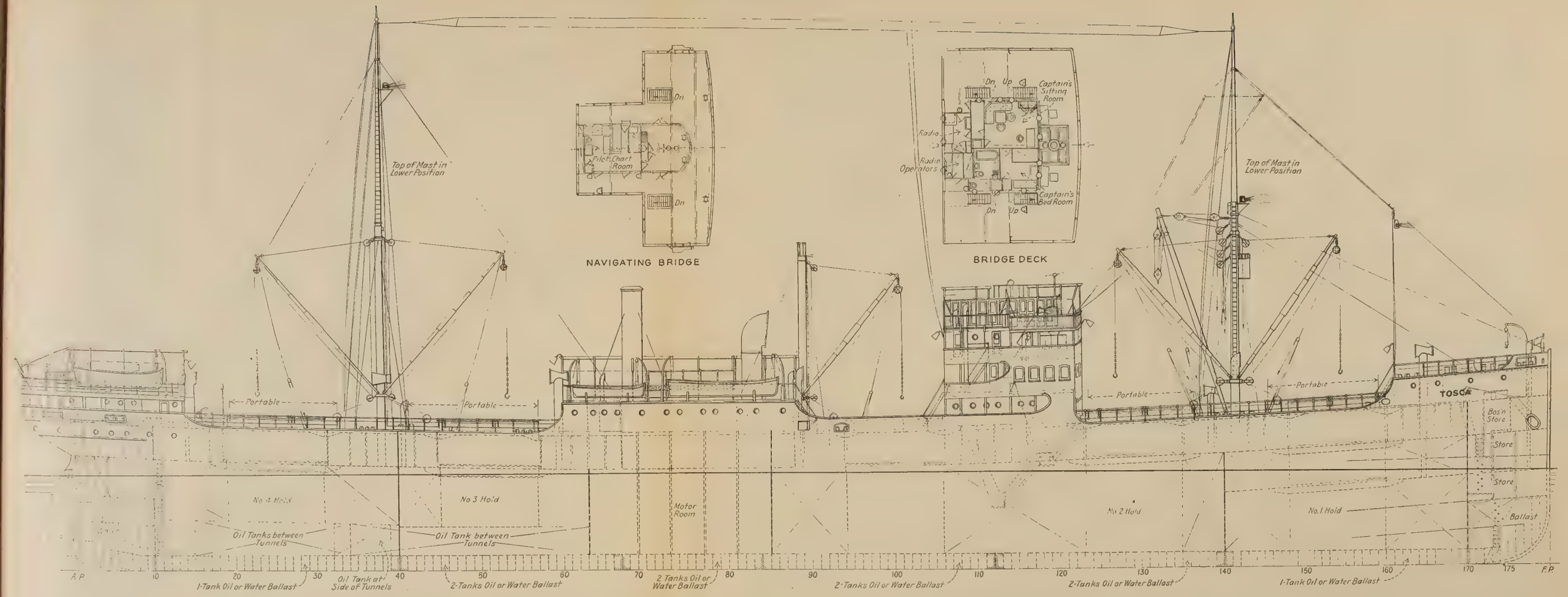


AFTER BOAT DECK



FORECASTLE DECK

MOTORSHIP TOSCA



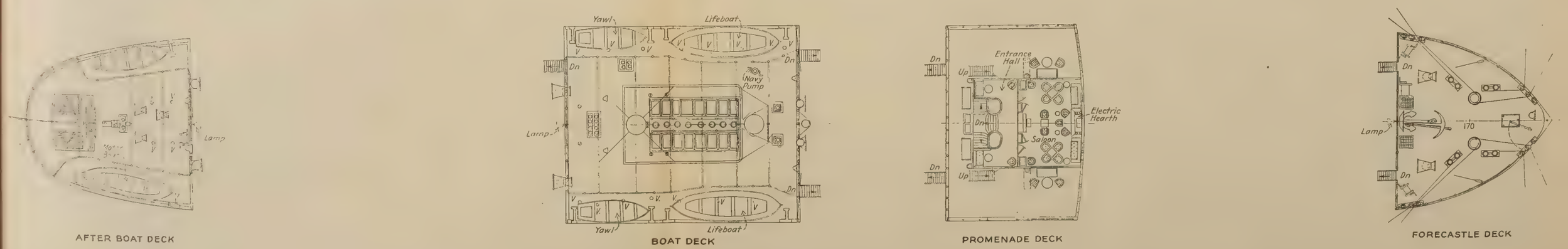
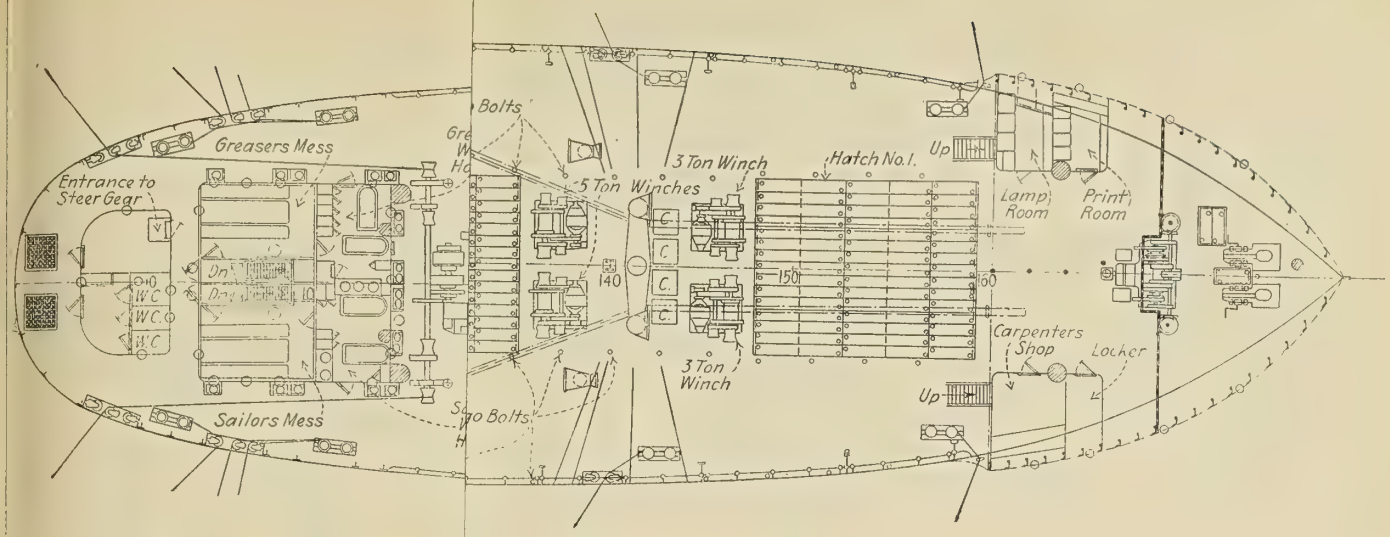
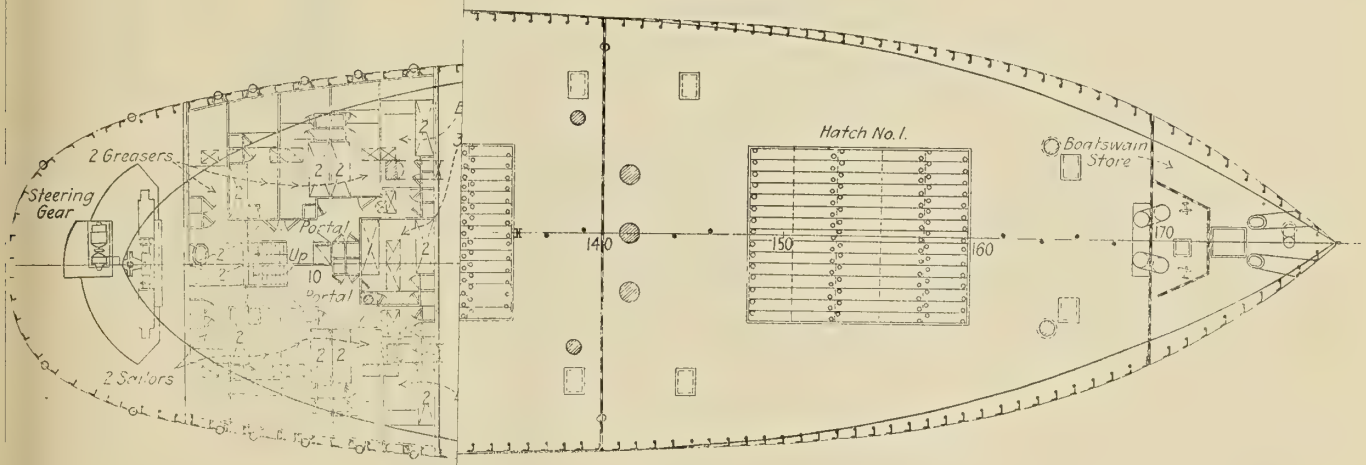
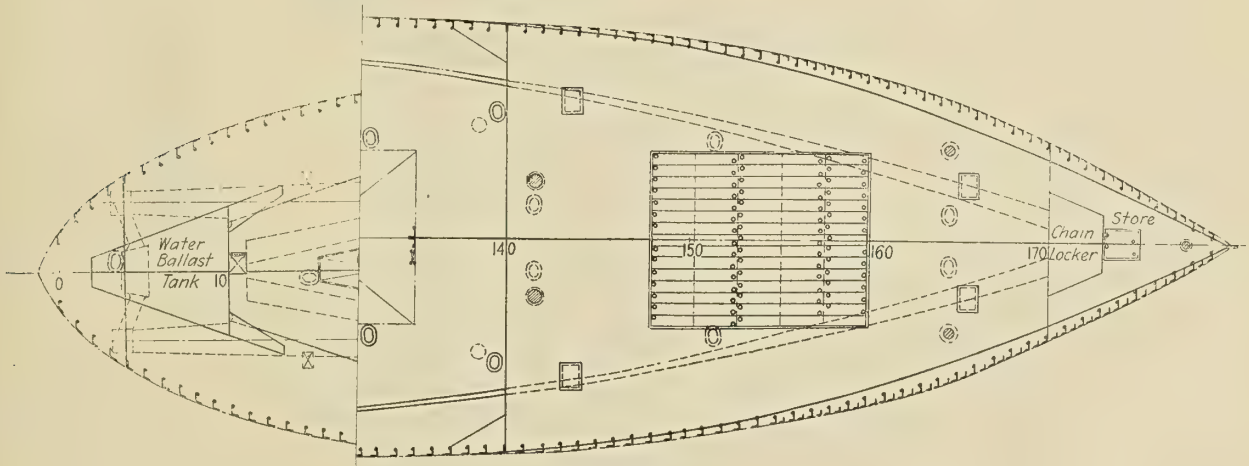


Fig. 2.—Profile and Superstructure Deck Plans

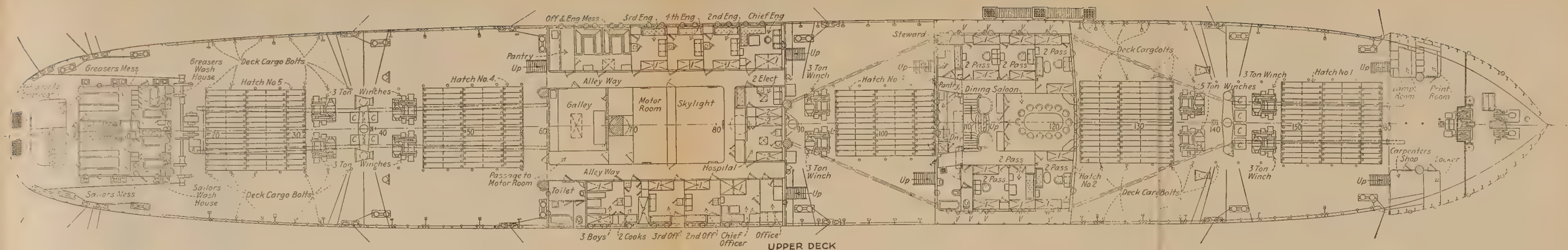

Greasers Mess
Entrance to Steer Gear
Bolts
3 Ton Winch
Hatch No. 1.
Up
5 Ton Winches
Lamp Room
Print Room
140
150
160
Carpenters Shop
Locker
3 Ton Winch
Up
Sailors Mess
Bolts

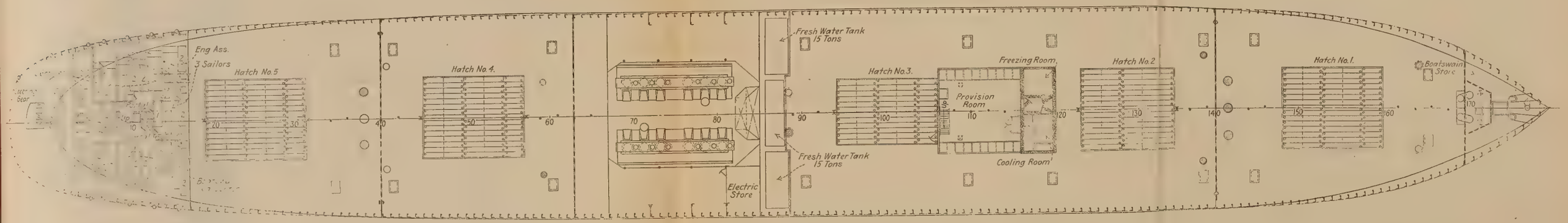

2 Greasers
Steering Gear
Portal
Up
10
Portal
2 Sailors
Hatch No. 1.
Boatswain Store
140
150
160
170


Water Ballast Tank
0
10
140
150
160
170
Chain Locker
Store

LOWER DECK

MOTORSHIP TOSCA





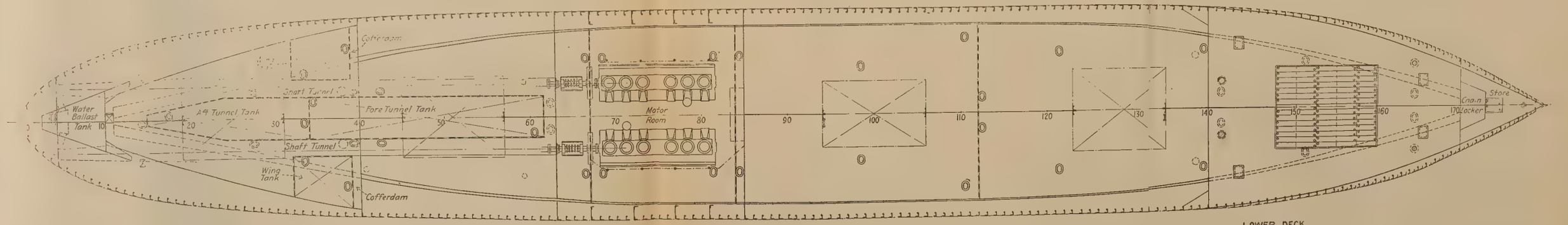


Fig. 3.—Deck Plans

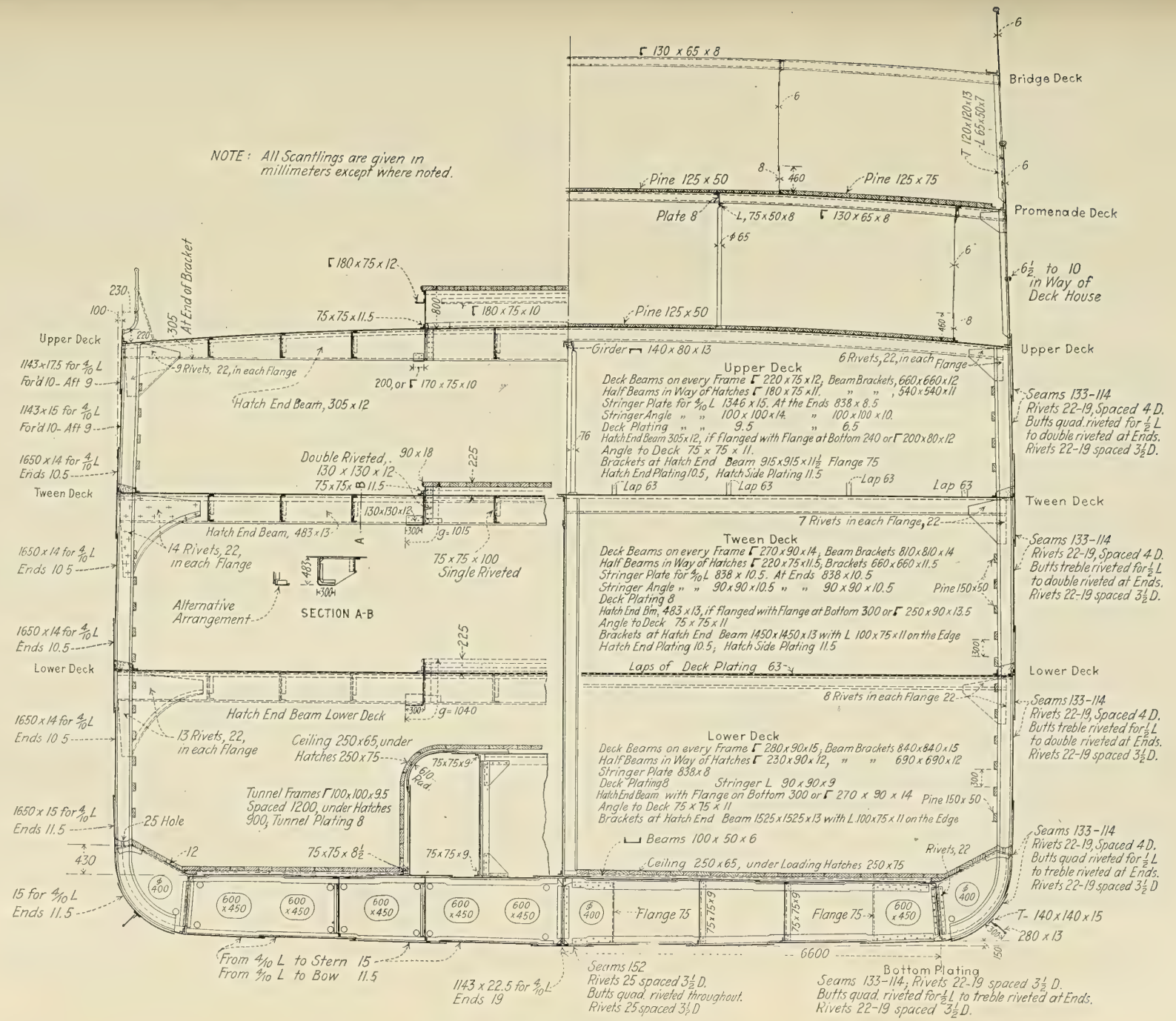


Fig. 4.—Midship Section, M. S. *Tosca*

Principal Dimensions:

Length over all	114.30	M
Beam, Molded	15.620	"
Height of Upper Deck	2.591	"
" " Lower " to 'Tween Deck	3.050	"
" " Promenade Deck	2.600	"
" " Fo'c's'le Deck	2.133	"
" " Boat "	2.362	"
" " Bridge "	2.600	"
Camber " Upper Deck	0.315	"

No Camber in 'Tween Deck and Lower Deck

Note: All Dimensions given in Millimeters except as noted.

Class+1A1. with Freeboard N.V. Veritas Numbers

Length Number L $(\frac{1}{2}B+D+\frac{1}{2}G)$ = 3486.0
Width " $\frac{1}{2}B+D+\frac{1}{2}G$ = 30.5
Topside " L $(\frac{1}{2}B+D+\frac{1}{2}G)(\frac{L}{10(D+H)})^2$ = 4244.0
H = Height of Shelter Deck = 2.591 M
$\frac{1}{2}G$ = Half Circumference on Outside of Frames, from Center of Keel to Under Side of Stringer Plate of Upper Deck = 14.925 M

Equipment

Equipment Number = $L(\frac{1}{2}B+D+\frac{1}{2}G)+(2HL+2H_1L_1)$ = 4143 + Bridge = 4227
3 Stockless Bower Anchors; 2 of 3060 kg., 1 of 2530 kg.
1 Stream Anchor, Weight without Stock = 826 kg.
1 Kedge " " " " " = 356 kg
495 m. Chain of 57.5 Diam.
165 m. Steel Hawser for Stream Anchor, 121 Circumference.
220 m. " " ; 121 Circumf.
2-165 m. " Hawsers; 70 " .
2-165 m. " " ; 63 " .
Chain, 1.5 over N. V.

Riveting.

Butts:-
Upper Deck Stringer Plate, $\frac{1}{2}$L quadruple riveted, Ends double riveted, Rivets 22-19, sp. $3\frac{1}{2}$D. for $\frac{1}{2}$L, 4 D. at Ends.
'Tween " " " , $\frac{1}{2}$L triple " " " " " 19, " $3\frac{1}{2}$ " " $\frac{1}{2}$", 4 " " "
Lower " " " , Single over Entire Length; Rivets 16, sp. 4 D.
Fo'c's'le " " " , " " " " " 19, " 4 ".
Remainder of Deck Plating, $\frac{1}{2}$ L double, Ends single; Rivets 19-16; sp. $3\frac{1}{2}$-4 D. for Upper and 'Tween Deck, 4 D for Lower Deck.
Butts of Side Plating and Double Bottom Rider Plate $\frac{1}{2}$L triple riveted, Ends double. Rivets 19; spaced $3\frac{1}{2}$D.
Remainder of Double Bottom Plating $\frac{1}{2}$L double riveted, Ends single; Rivets 19; spaced $3\frac{1}{2}$ D.
C.V. Keelson triple riveted over entire Length, Rivets 22-19, spaced $3\frac{1}{2}$ D.

Laps:-
Decks- Single Riveted 22-16 Rivets; spaced $4\frac{1}{2}$ D.
Double Bottom Rider Plate - double; Riv. 19 ; spaced $3\frac{1}{2}$ D.
Remainder of Double Bottom Plating - single riveted. Rivets 19 ; spaced $3\frac{1}{2}$ D.
Shell - Double Riveted over entire Length Rivets 22-19. spaced $3\frac{1}{2}$-4 Dia

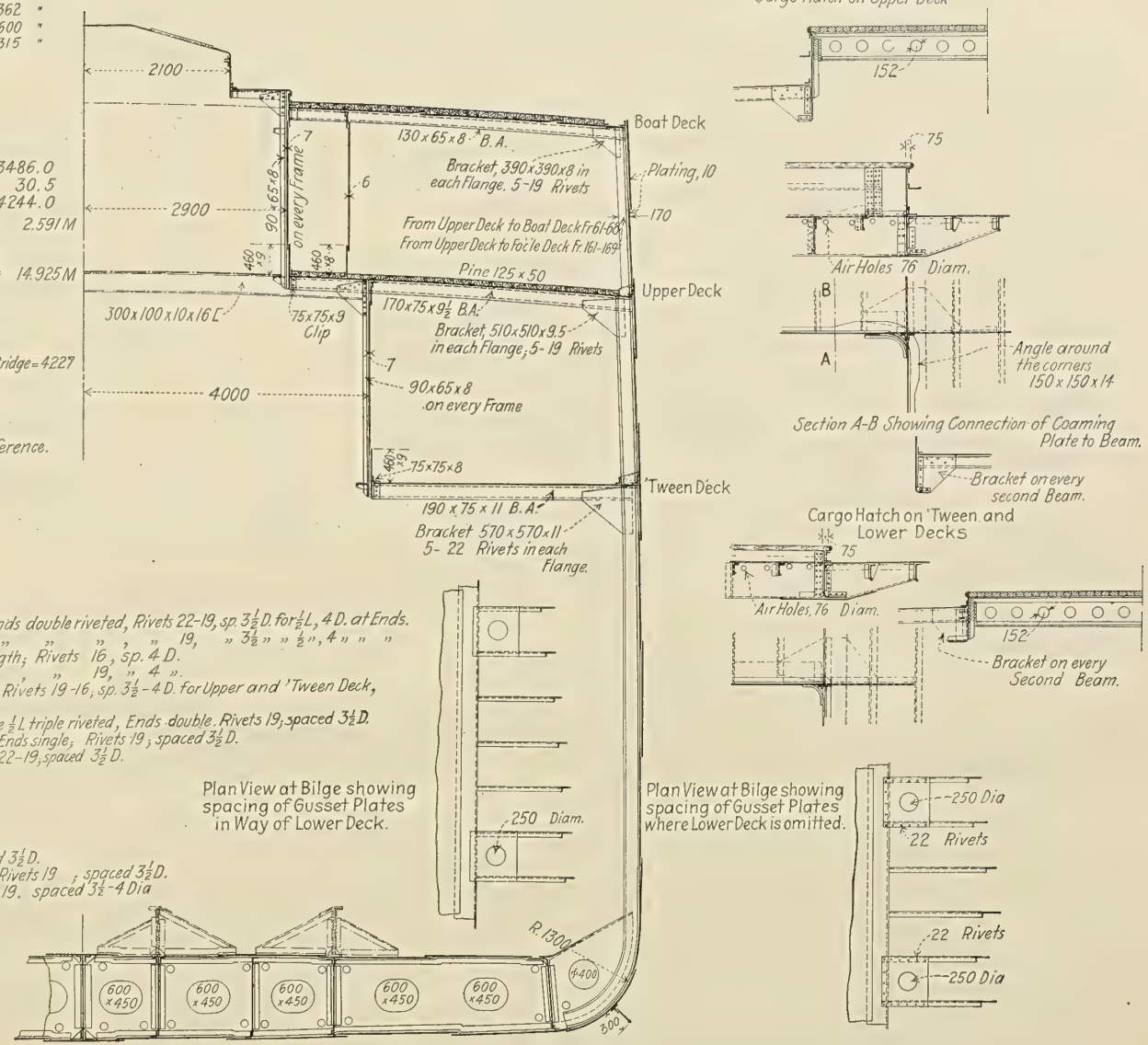


Fig. 5.—Section in Way of Machinery Space, M. S. *Tosca*

and piston cooling water pump; driven by a single electric motor.

An oil fired donkey boiler with a heating surface of 265 square feet.

Cargo Handling Gear

The cargo is handled by eight 3-ton booms and two 5-ton booms, an additional boom of 25 tons capacity being located at hatch number 2.

Deck Machinery

Ten electric deck winches are provided for handling the leads from the cargo booms.

An electric driven windlass is located below the forecastle deck forward and is geared to drive two capstans located on the deck above.

A warping gear, which is also electrically operated, is located on the upper deck just forward of the poop deck house.

The main steering gear is of the Hele-Shaw-Martineau electric hydraulic type. It is located in the poop and operated from the bridge by telemotor control.

A spare steering gear is provided on the poop deck. This is a hand operated gear and is direct connected to the rudder-head by a left and right worm transmission.

The motors for all deck machinery were furnished by the Electrotechnische Industrie of Messrs. Smit at Slikkerveer.

Lifeboats

Two lifeboats and two dinghies are located on the boat deck over the engineers' and officers' quarters and a motorboat is carried on the poop. All boats are handled by Welin davits and a spare set of davits is also provided, being located on the poop deck.

Ore and Oil Steamers Marore and Steelore

Two 20,500-ton deadweight combination ore and oil steamers are now under construction at the Sparrow's Point plant of the Bethlehem Shipbuilding Corporation, Ltd., for the Ore Steamship Corporation of New York city. The vessels are of the Bethlehem-Frear patent type and the cargo space is so arranged that a full load of either oil or ore can be carried in separate compartments. Oil will be transported from Tuxpan, Mexico, to Cruz Grande, Chile, whence ore will be carried to Sparrow's Point, Md. General cargo can be carried from Sparrow's Point to Mexico.

THE designs of the 20,500-ton combined ore and oil steamers now under construction by the Bethlehem Shipbuilding Corporation, Ltd., include a narrow elevated hold of great length and with sufficient capacity for a full deadweight cargo of iron ore. The space on each side and underneath the ore hold is divided into tanks 30 feet long which also have a combined capacity for a full deadweight liquid cargo. The effect of this combination is such that the center of gravity of both the ore and liquid cargoes is approximately at the same height as the center of gravity of general cargo properly stowed in a freighter of the ordinary type. This characteristic in combination with the relatively small sectional area of the ore hold extending over the greatest possible length of the vessel will have the tendency of reducing all stresses incident to carrying dense cargoes on an ocean voyage.

Ore and Oil Spaces

The ore space, which is 14 feet above the base, is 30 feet wide and has a combined length of 360 feet. It is divided by watertight bulkheads into three compartments. Each of these compartments is served by three large hatches extending the full width of the ore hold.

The oil space, alongside and below the ore space, is divided by a longitudinal bulkhead extending from the keel to the ore hold. The foremost and aftermost compartments are for fuel oil and the tanks between these are for cargo oil. The oil spaces differ from the ordinary tanker in that there are no summer tanks. The wing spaces act as expansion trunks and, on account of their depth, afford the greatest possible flexibility for carrying liquid cargoes of varying density and adjusting the trim under all conditions of load. Each oil tank is served by an oiltight hatch, 80 inches by 39 inches, with 30-inch coaming.

General Cargo and Stores

General cargo and stores are carried in the space just forward of the forward oil tank and in the 'tween deck space abaft the after oil tank. The forward general cargo space is served by 11-foot 6-inch by 9-foot cargo hatches.

The pump room is located between ore holds Nos. 1 and 2 below the ore hold, 30 feet long by 30 feet wide with a trunk 10 feet long by 30 feet wide extending to the weather deck. Under the pump room floor is a sump tank for draining ore holds Nos. 1 and 2. A sump tank is also fitted at the after end of No. 3 hold. The propelling machinery is arranged aft.

Construction

The vessels are built on the longitudinal system of framing with transverses spaced generally 10 feet apart. The ore hold side bulkheads are supported at every transverse by a wide transverse web and at each oil tank bulkhead by a fore and aft web. The span of the side transverses is shortened by the introduction of a transverse horizontal girder across to the ore hold between longitudinals 10 and 11. The depths of the transverses above this girder are varied with the increase in the depth of the vessel due to shear, being 36 inches where the depth is 44 feet and attaining a maximum of 42 inches where the depth is 47 feet 8 inches.

The framing of the bottom and side shell follows the usual practice for tankers.

The ore hold longitudinal bulkheads are sheathed with 2½-inch pine to above the height at which ore will be loaded. The floor of the ore hold, however, is not sheathed but is formed of ⅞-inch plating with sight edges of seams facing inboard so as not to catch the unloaded grab buckets.

The hatch covers to the ore holds are of the Hogg-Carr steel corrugated hinged type made of ⅜-inch plating. The covers are of two parts, one-half hinging forward and the other hinging aft. Each cover is fastened down by fifty-eight 1½-inch dog bolts, and the joint between the two parts is drawn up tight by 1½-inch bolts.

Cargo Handling

The taking on of an oil cargo at Tuxpan, Mexico, presents a problem no different from that of the ordinary tanker. Three oil hose cranes and filling manifolds are located on each side of the upper deck and fill through 12-inch risers to the hold. For discharging oil, 10-inch suctions in each tank

Ore and Oil Steamers Marore and Steelore

General Information

Service: Oil and iron ore, Tuxpan, Mexico, to Cruz Grande, Chile, to Sparrow's Point, Md.

Builder: Bethlehem Shipbuilding Corporation, Ltd., Sparrow's Point (Md.) plant.

Owner: Ore Steamship Corporation, New York City.

Characteristics

Length, overall.....571 feet 6 inches
Length, B. P.....550 feet 1 inch
Breadth, molded.....72 feet
Depth, molded.....44 feet
Draft, loaded, designed....32 feet 4 inches
Draft, light, estimated.....10 feet 9 inches
Block coefficient.....0.817
Midship section coefficient.....0.989
Longitudinal coefficient.....0.826
Speed, loaded trial, knots.....11½
Cruising radius, nautical miles
20,000 at 10.5 knots
Framing .....Longitudinal
Class....A-1 American Bureau of Shipping

Tonnages

(In tons of 2,240 pounds)

*Weight of hull.....	8,150
**Weight of propelling machinery....	950
Deadweight capacity	20,500
Displacement	29,600

(In tons of 100 cubic feet)

Gross register (calculated).....	15,400
Net register (calculated).....	9,479

* Weight of hull includes hull proper, hull fittings, equipment and outfit.
** Weight of propelling machinery includes engines, boilers (wet), shafting, propellers and machinery space auxiliaries.

Canal Ratings

(In tons of 100 cubic feet)

	Gross	Net
Suez		
Panama (calculated).....	15,712	11,284

Equipment

Anchors:
2 bower, stockless, each.....14,105 lbs.
1 " " .....12,005 "
1 stream, " ..... 5,040 "
1 kedge, " ..... 2,135 "
Chain cable, 330 fathoms, 2⅞" dia.
Stream chain, 105 fathoms, 1 9/16" dia., or 5½" circ. steel wire.
Towline, 140 fathoms, 7" circ. steel wire.
Hawsers, 3 each 90 fathoms, 8½" circ. manila.
Warps, 3 each 90 fathoms, 7½" circ. manila.

Rudder

Area, abaft centerline of pintles.....244 square feet.
C. G. abaft centerline of pintles....4.66 feet
Diameter of stock.....15 inches

Complement

Deck officers	5
Deck crew	19
Engineer officers	7
Engineer crew	12
Stewards' department	10
Total officers and crew	53

Handling Equipment

	No.	Type	Capacity	Length
Masts	2	Pole		129 feet above deck
Derrick posts	10	Circular	3-ton	32 feet high
Booms	18	Oregon Pine	3-ton	36 feet

Deck Machinery

Steering gear.....16" by 12"-screw gear.
Windlass (1)...13" by 13"-triple spur gear.
Cargo winches (10).....8¼" by 10" compound geared.
(1).....9" by 12" compound geared.
Mooring winches (6).....10" by 12" special type.

Life Saving Equipment

	No.	Type	Length
Lifeboats	4	Bethlehem	26 feet
Work boat	1	Bethlehem	16 "
Life raft	1	Behlehem	25 persons

Propelling Machinery

Boilers

Number 3
Type.....Single-ended Scotch
Length .....12 feet
Diameter.....17 feet 6 inches
Furnaces.....4 per boiler
Fuel .....Oil
Draft .....Howden system
Total heating surface, square feet....12,861
Total furnace volume.....2,226 cu. ft.
Superheat, degrees F. 600
Working pressure, lbs. per sq. in. 220
Normal fuel consumption:
Per day, tons.....43
Per horsepower hour, pounds.....0.9
Normal steam production:
Per hour per lb. of fuel, lbs., about 15
Total per hour, lbs.....54,000

Engines

Number 2
Type....Curtis turbines, Falk single reduction gear.
Shaft horsepower, normal 4,500
maximum 5,000

Propellers

Number 2
Type.....3-bladed, solid, machined
Weight.....16,000 lbs. each
Diameter .....15 feet 8 inches
Pitch.....12 feet 8 inches
R. P. M. 105
Projected area, square feet.....56.8
Developed area, square feet.....65.6

Auxiliary Machinery

Refrigerating Machinery

2 2-ton Brunswick ammonia direct expansion machines.

Engine Room

Condensers—2 main: total cooling surface 4,000 sq. ft.
1 aux: total cooling surface 1,000 sq. ft.
Evaporators—2 30 ton
Feed water heater—1 multiflow
Pumps

2 Main circ., 14" centri.; engine, 9" by 8" recip.
2 Main air, 9½" by 17" by 15" independent dual with augmentor jets.
1 Com. aux. air and circ., 12" by 14" by 14" by 12".
2 Main feed, 15½" by 11½" by 24" v. s.
4 Forced lubr. oil, 7" by 8" by 18" v. s.
1 Fire and general service, 10½" by 8" by 22" v. s.
1 Main bilge, 7" by 8" by 18" v. s.
1 Sanitary and 1 bilge, attached, each 6½" by 7½" inclined simplex.
1 Fresh water and 1 sanitary, each 4½" by 5" by 12" v. s.
2 Water circ. for lubr. oil, 9" by 10" by 21" v. s.
1 Grease extractor, 3" twin gravity flow.
1 Lubricating, oil cooler.

Boiler Rooms

1 Fuel oil transfer pump, 7" by 8" by 18" v. s.
2 Fuel oil service pumps, 7¼" by 5" by 10" h. d.
3 Fuel oil heaters.
1 Donkey boiler, Scotch, 1 furnace, 317 sq. ft. h. s.
1 Donkey boiler feed pump, 5" by 3½" by 6" v. s.
Forced draft blower....Howden, 90" fan, 2-8" by 16" vert. eng.

Forward Pump Room

2 Cargo oil pumps, 14" by 20" by 16½" by 24", compound h. d.
1 Ballast pump, centr., 100 h. p. turbine.
1 Transfer pump, 7" by 8" by 18" v. d.
1 Bilge pump, 7" by 8" by 18", v. s.

Electric Equipment

2 20-K. W., 115 volt, generators, G. E., driven by 9" by 7" vert. recip. eng.

Holds

No.	Length	Hatches
1 ore.....	120'0"	2 30'0" x 30'0" 1 19'0" x 30'0"
2 ore.....	130'0"	3 30'0" x 30'0"
3 ore.....	100'0"	1 25'0" x 30'0" 2 30'0" x 30'0"
1 to 11, oil.....	30'0"	1 each 80" x 39"

Capacities

Cargo Space

Compartment	Bales Cu. Ft.	Bulk Cu. Ft.
No. 1 Ore hold	121,000	121,000
No. 2 Ore hold	125,300	125,300
No. 3 Ore hold	106,500	106,500
Total ore space	352,800	352,800
For'd upper 'tween decks	15,547	16,477
" lower " "	22,222	23,228
Aft 'tween decks, port	5,102	5,694
" " " starboard ...	6,382	7,135
Total general cargo	49,253	52,534

Cargo Oil Tanks*

	Cu. Ft.	Gallons	Bbls.	Tons
No. 1	71,116	531,948	12,665	1,812
No. 2	70,350	526,218	12,529	1,793
No. 3	65,244	488,026	11,620	1,663
No. 4	60,290	450,970	10,737	1,536
No. 5	68,064	509,118	12,122	1,735
No. 6	67,748	506,756	12,066	1,726
No. 7	67,748	506,756	12,066	1,726
No. 8	67,748	506,756	12,066	1,726
No. 9	68,024	508,820	12,115	1,734
No.10	68,146	509,732	12,136	1,737
No.11	66,816	499,784	11,899	1,703
Total cargo oil	741,294	5,544,884	132,021	18,891

Fuel Oil Tanks*

Frs. 23-25	40,574	303,494	7,226	1,068
" 58-61	61,126	457,222	10,886	1,609
Deep tank	30,312	226,734	5,398	798
Total fuel oil ..	132,012	987,450	23,510	3,475

* Oil capacities given are net for both sides of ship, with no allowance for expansion. 1 cu. ft. = 7.48 gals.; 42 gals. = 1 barrel; 38 cu. ft. = 1 ton.

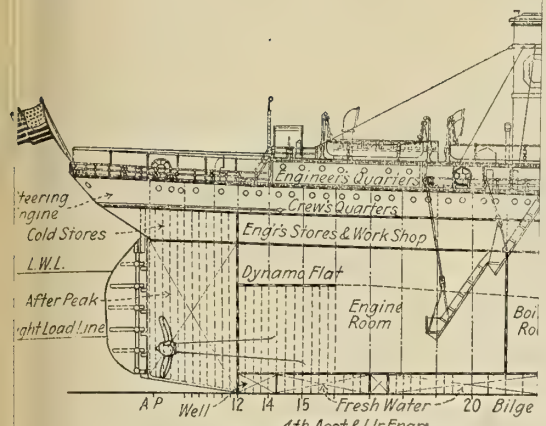
Refrigerated Space

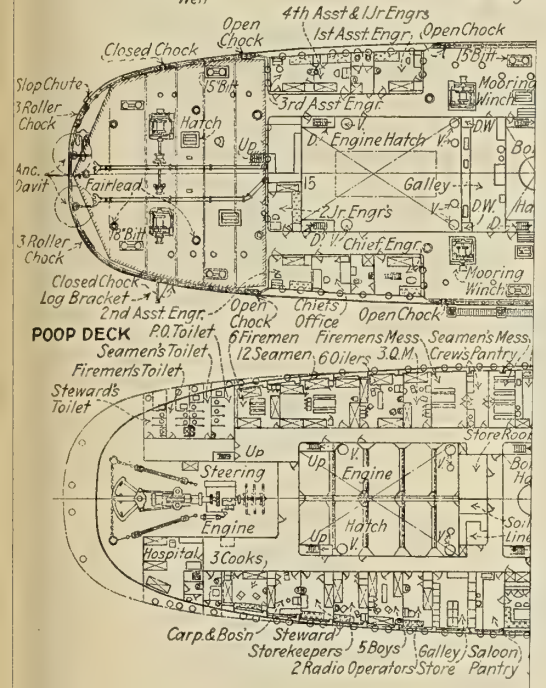
Meat room.....1,418 cubic feet
Vegetable room.....1,245 cubic feet

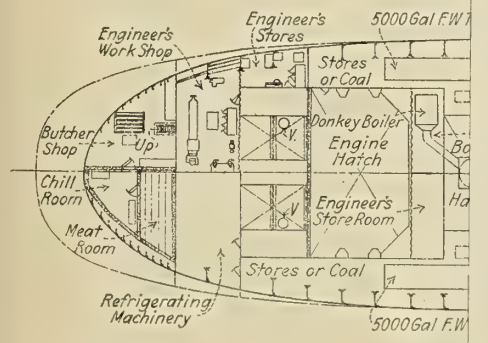
Tanks

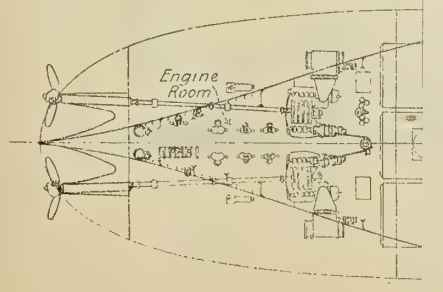
Compartment	Cu. Ft.	Tons F. W.	Tons S. W.
Fore peak tank	23,170	....	662
Tanks on lower deck	1,336	37	....
Double bottom, 14¼-17	1,795	50	....
" " 17½-23-1/3 .	7,129	198	....
After peak tank	11,272	313	322
Total	44,702	598	984

ORE AND


Engineers Quarters
Crew's Quarters
Steering Engine
Cold Stores
Engr's Stores & Work Shop
L.W.L.
Dynamo Flat
After Peak
Engine Room
Light Load Line
AP
Well
12
14
15
Fresh Water
20
Bilge


4th Asst & 1Jr Engrs
Open Chock
1st Asst Engr.
Open Chock
Closed Chock
Slop Chute
3 Roller Chock
Hatch
Up
3rd Asst Engr.
Mooring Winch
Engine Hatch
Anc. Davit
Fairlead
Galley
2 Jr Engrs
Chief Engr.
Mooring Winch
Closed Chock
Log Bracket
2nd Asst Engr.
Open Chock
Chiefs Office
Open Chock
POOP DECK
P.O. Toilet
6 Firemen
Firemens Mess
Seamen's Mess
Seamen's Toilet
12 Seamen
6 Oilers
3 Q.M.
Crews Pantry
Firemen's Toilet
Steward's Toilet
Store Room
Steering Engine
Engine
Hatch
Hospital
3 Cooks
Carp. & Bosn
Steward
Storekeepers
5 Boys
Galley
Saloon
2 Radio Operators
Store
Pantry


Engineer's Stores
5000 Gal F.W.T.
Engineer's Work Shop
Stores or Coal
Donkey Boiler
Butcher Shop
Up
Engine Hatch
Chill Room
Engineer's Store Room
Meat Room
Stores or Coal
Refrigerating Machinery
5000 Gal F.W.


Engine Room

ORE AND OIL STEAMERS MARORE AND STEELORE

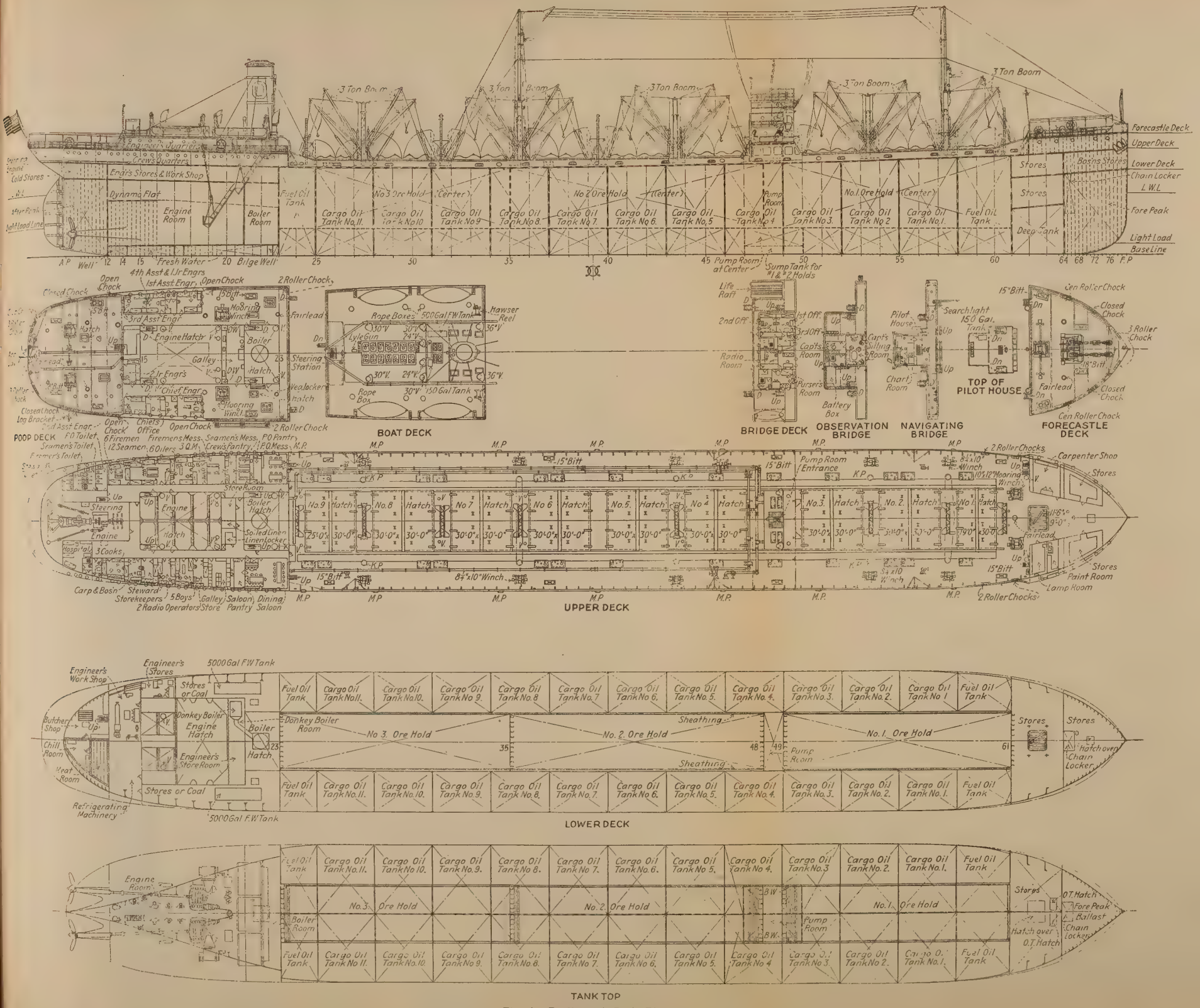


Fig. 1.—Profile and Deck Plans

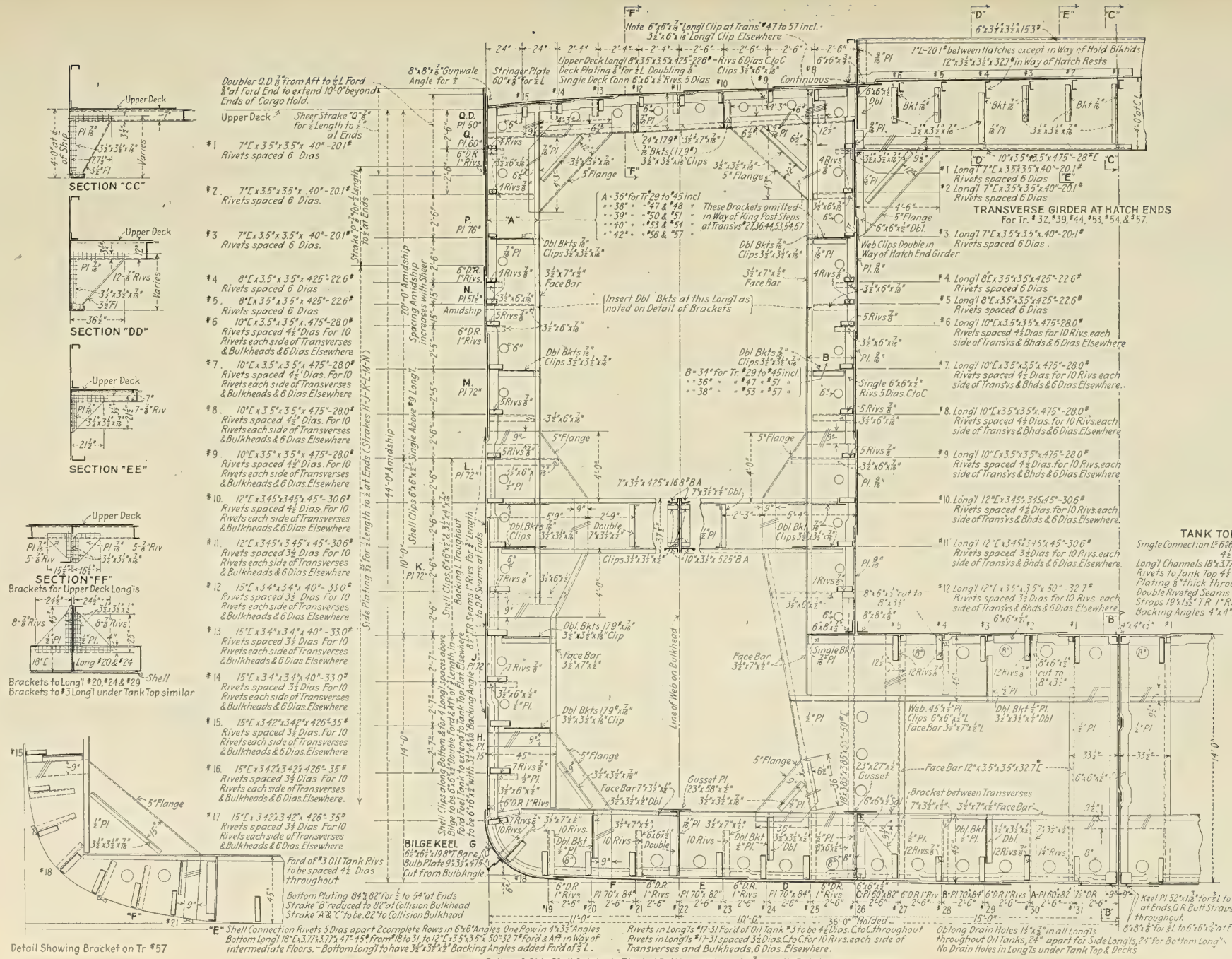


Fig. 2.—Midship Section, S. S. *Marore* and *Steelore*

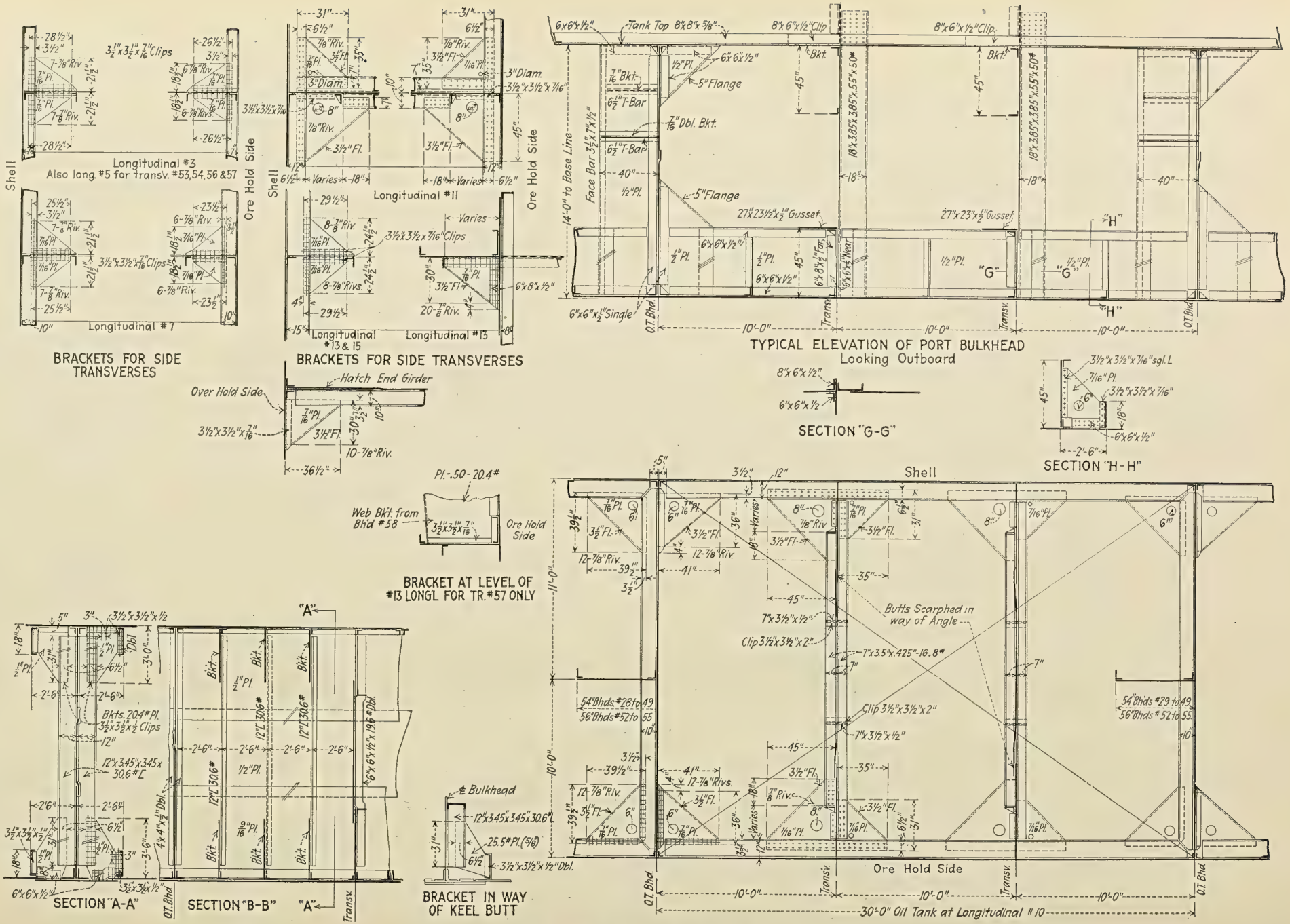


Fig. 3.—Midship Section Details, S. S. *Marore* and *Steelore*

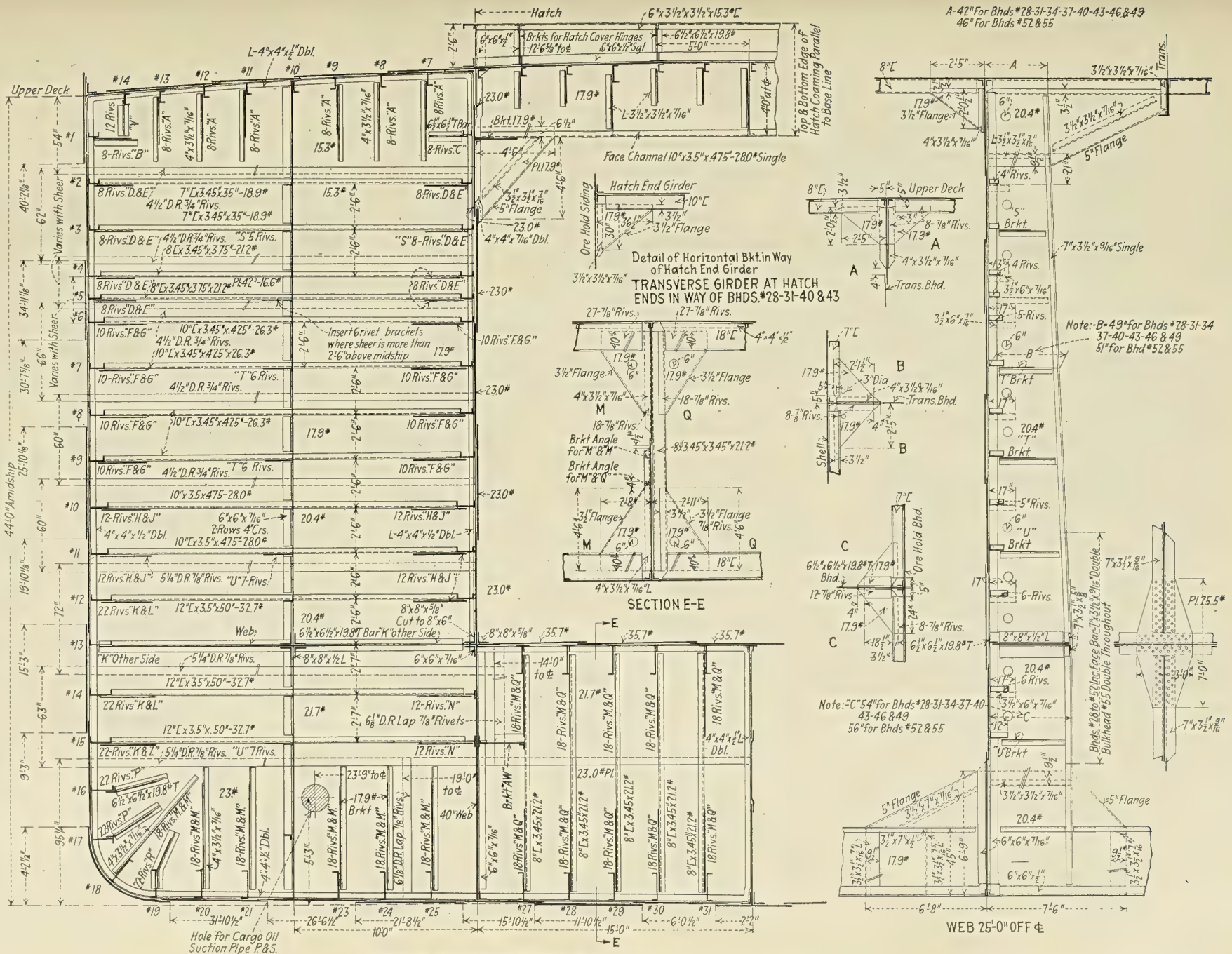


Fig. 4.—Oil-Tight Bulkhead, S. S. *Marore* and *Steelore*

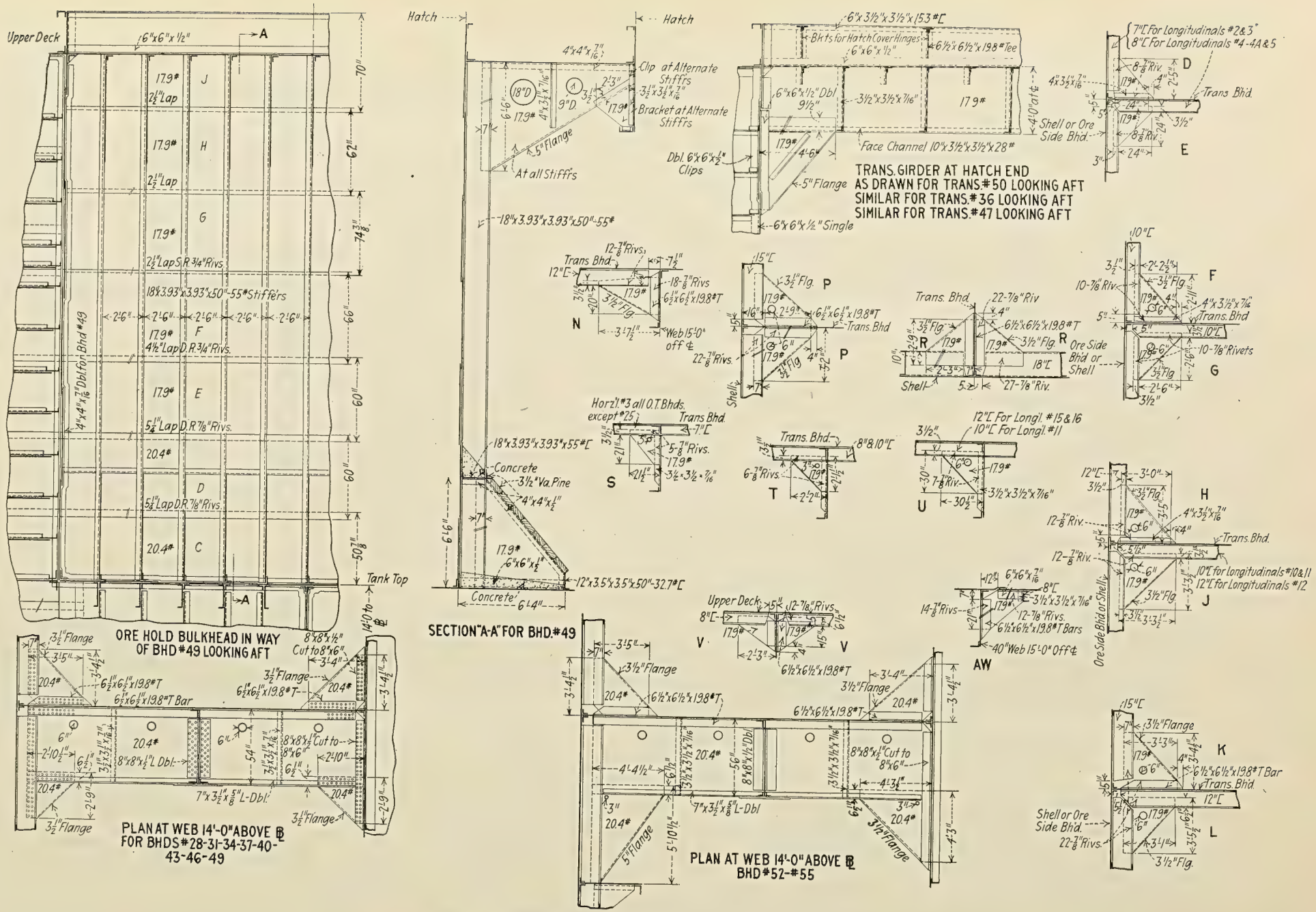


Fig. 5.—Oil-Tight Bulkhead Details, S. S. *Marore* and *Steelore*

discharge into the 14-inch fore and aft hold suction lines, one on each side of ship. The two horizontal duplex cargo pumps discharge through port and starboard 12-inch risers and through 12-inch discharge lines on the upper, boat and poop decks leading over the stern. Cargo and fuel oil tanks are provided with an efficient steam heating system.

Ore is loaded at Cruz Grande, Chile, after the oil cargo has been discharged. The discharging of ore at Sparrow's Point is done under two 15-ton grab bucket unloaders, and can be accomplished in about 40 hours. The area of the ore holds is so proportioned to the speed of the unloaders that the surface of the ore remains at a constant level relative to the unloaders as the ship loses draft due to the decreased weight.

Ten kingposts, with eighteen 36-foot Oregon pine booms of three tons capacity, are provided for the handling of cargo in the event of these ships becoming engaged in some other trade not having terminal facilities for loading and unloading. The ten 8¼-inch 10-inch winches which handle the tackle for opening the Hogg-Carr hatch covers are available for working the ¾-inch diameter wire rope whips on the cargo booms.

Warping and Mooring Gear

The warping gear on these ships has been given very careful attention. The Bethlehem-Moore triple spur geared 13-inch by 13-inch windlass handles the 2⅞-inch anchor chain. Aft of this on the forecastle deck is a Bethlehem-Moore compound geared 9-inch by 12-inch winch with extension heads. On the upper deck forward, on the poop deck forward of the wing houses and again on this deck aft special mooring winches are fitted. These are of the Bethlehem-Moore 10-inch by 12-inch type and are intended for mooring to buoys at sea in a relatively fixed position, or two wharves while loading or unloading. In operation this type of winch automatically pays out the warping line when under excessive tension and establishes the necessary tension should the line become slack for any cause.

Steering Gear

The steering engine is of Bethlehem-Moore 18-inch by12-inch screw gear type, with the three hand steering wheels located forward of the engine. The control is by the Bethlehem duplex ram hydraulic telemotor from the transmitter stand in the pilot house. The ship can also be steered by an emergency gear connected to the spring quadrant and operated by the mooring winches on the poop deck.

Ventilation

The fireroom is ventilated by two 36-inch, and the engine room by four 30-inch diameter cowls, operated from below. The quarters are ventilated by 10-inch mushroom vents and the pump room by two 24-inch cowls. Fourteen 20-inch diameter ventilators with hinged tops are provided for the ore holds. The oil tanks are vented as follows: The forward deep tank by two, and the remaining fuel oil tanks by one each, 6-inch gooseneck vents. Cargo oil tanks Nos. 6, 7, 9 and 10 are vented through 3-inch pipes led up the nearest kingpost to about twenty feet above the deck. Tanks Nos. 3 and 4 have pipes led up the midship structure. Tanks Nos. 1, 2, 5, 8 and 11 are vented through the kingposts. Bethlehem standard 4-inch vapor valves are fitted to each vent pipe and at top of kingposts.

Quarters

Accommodations for deck officers are provided in a midship superstructure located over the pump room and supported on five transverse frames, the sides between the bridge and upper decks not being plated above the 42-inch height of the bulwark. The bridge deck, 10 feet above the upper deck, is plated and planked with 3½-inch Oregon pine.

The steel house on this deck contains the captain's office and purser's room and bath, the first, second and third officers' staterooms, an officers' bath, the radio room and a medicine locker. It should be noted that no officers' dining saloon is located in the midship quarters. The observation bridge is decked with 3½-inch Oregon pine, and in the steel house are the captain's stateroom, sitting room and bath. The quarters on this deck and the bridge deck below are finished in white enamel with mahogany trim. The stateroom floors are covered with carpets and the bathroom floors with hexagonal tile.

On the upper deck aft, in way of the poop, are located the officers' dining saloon, crew's mess rooms, crew's quarters, hospital and steering engine room. The officers' dining saloon walls and ceiling are paneled in oak; the crew's mess room's and quarters are of cypress, finished bright. The upper deck, in way of the quarters aft, is planked with 3½-inch Oregon pine, as is also the poop deck, except at the extreme after end.

Quarters for the engineer officers are located on the poop deck, abreast the engine hatch. These quarters are finished similarly to those in the midship houses. The galley is also located on this deck between the engine and boiler hatches.

A complete steam heating system designed for 65 pounds working pressure is installed in all quarters.

The officers' and engineers' baths are provided with showers and heaters, having hot or cold salt water, and lavatories having cold fresh water. The crew's toilets aft have hot or cold salt water to showers and cold salt water to wash basins. Fresh water is carried in two 5,000-gallon tanks on the lower deck in the machinery space and in a 500-gallon gravity tank on the boat deck and in a 150-gallon gravity tank on the wheel house top. The plumbing fixtures are of good quality throughout.

Propelling Machinery

The vessels are propelled by two Curtis turbines with Falk single reduction gears manufactured at the Fore River plant of the Bethlehem Shipbuilding Corporation.

Steam is supplied by three Scotch boilers fitted with the Bethlehem-Dahl fuel oil burning system. Howden's system of forced draft is fitted. The boilers are being made at the corporation's Sparrow's Point plant and the oil burning system at the Redington plant.

Auxiliaries

All of the auxiliary machinery is of the Bethlehem type with the exception of the refrigerating machinery, which is of the Brunswick type, the auxiliary air and circulating pump (Alberger), the grease extractor (Row and Davis), the lubricating oil cooler (Griscom-Russell No. 114 multiwhirl), the cargo oil pumps (National Transfer Company), the ballast pump (Dravo-Doyle with DeLaval turbine) and the generators (General Electric). Most of the pumps are manufactured at the Moore plant of the Bethlehem Corporation.

A donkey boiler is located on a flat between the engine and boiler rooms at the lower deck level. The engineers' store rooms and workshop are provided on this same deck on the port side, and the refrigerating machinery is located on the starboard side. At the extreme after end of this deck are the meat room, chill room and butcher shop.

The vessels described above are the Bethlehem hulls 4,212 and 4,213, named the *Marore* and *Steelore*. Bethlehem hull, 4,210, building for the International Petroleum Company, is not yet named and hull 4,211 for the Ore Steamship Company is called the *Bethore*. These last two hulls are similar to those described above except that the main engines are triple expansion reciprocating with cylinders 25-inch, 41-inch and 68-inch diameter and a 48-inch stroke and that there is some difference in the arrangement of quarters aft. Bethlehem hulls 5,309 and 5,310, building at the Union plant of the Bethlehem Corporation at San Francisco, are called the *Chilore* and *Lebore*, and are similar to the *Marore* except that the hold space is designed to carry coal and ore instead of oil and ore. A description of the special construction adopted for this purpose will be given in a later issue.

Fig. 1.—White Star Third-Class Passenger Steamship *Vedic*

The Third-Class Carrier Vedic

White Star Line Adds Well-Equipped Liner for Third-Class Service Between New York and Liverpool

FROM a construction standpoint few vessels that have come out in the post-war period present more interesting points than the White Star Line's third-class carrier *Vedic*. This vessel was designed to meet a new condition in steerage traffic, namely, a demand for one-class ships. The tendency to abandon the steerage as such, has been marked since the end of the war. The leaven of democracy appears to have reached the transatlantic passenger trade with fully as much force as it has exerted in every country on the globe. The third-class traveler is no longer contented to be thrust into unsanitary quarters in the forepeak, or next to the rudder post, on a ship carrying first and second-class passengers in their best accommodation.

The result has been not only the improvement of third-class accommodation on the run of passenger vessels, but the construction of the third-class liner, so-called, of which the *Vedic* is an excellent example. This vessel, which was built by Harland & Wolff, Ltd., Belfast, Ireland, for the Oceanic Steam Navigation Company (The White Star Line), in the normal course of events would have gone into the passenger trade much earlier than she did. She came off the ways in 1914 and was immediately pressed into the service of the admiralty as a freighter and trooper, serving in these capacities throughout the war.

The ship was not at all known to the public when turned back to her owners in 1920 to be fitted up with passenger accommodation. Therefore, she came out early in 1921 virtually as a new ship, and on her first voyage to New York received considerable attention, being styled by her agents, "the ship of democracy." At that time, owing to a strike of British joiners, the ship's passenger quarters were not quite completed, but the work has since been finished, and the *Vedic* is now functioning fully on the run between New York and Liverpool, and is rendering very satisfactory service.

Principal Dimensions

A twin-screw vessel of 9,300 gross tons, the *Vedic* has the following dimensions:

Length overall	480 feet 7 inches
Breadth	58 feet 4 inches
Depth	34 feet

The ship's construction is rated A-1 in Lloyds. Her lines are pleasing and powerful, the distinguishing features being a cruiser stern, with white superstructure, a short forecastle head and a finely drawn, though powerfully flaring bow. She has one stack, placed almost directly amidships, and two masts with combination cargo derricks attached. She also has a very fine equipment of winches for the handling of

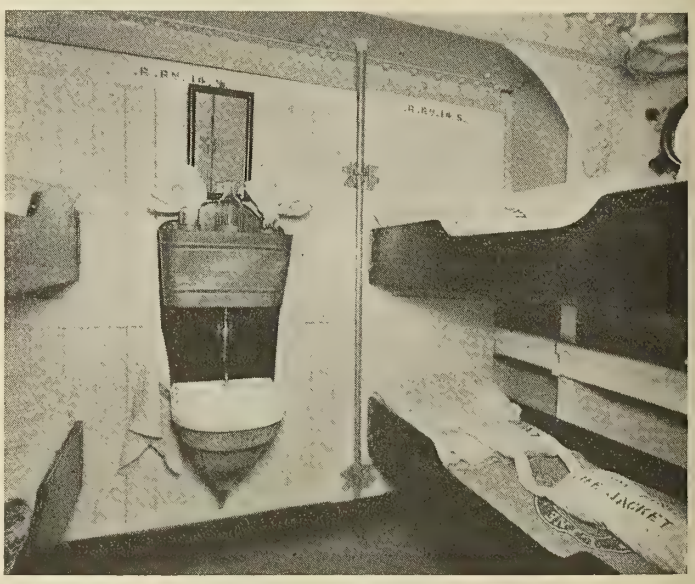


Fig. 2.—Four-Berth Stateroom

a large cargo. Her deck arrangements take into account, however, the need for promenading space for the passengers, and a proper balance has been struck between the space taken for equipment and that left for this purpose. As a matter of course, the vessel is equipped with boatage sufficient to take care of her total passenger complement and her crew, in case of necessity. Her sheer is graceful, and on the whole her appearance would do credit to a first-class liner.

Subdivision

The ship's hull is divided by ten watertight bulkheads into

Fig. 3.- One of the Three Dining Saloons

Fig. 4.—Smoking Room

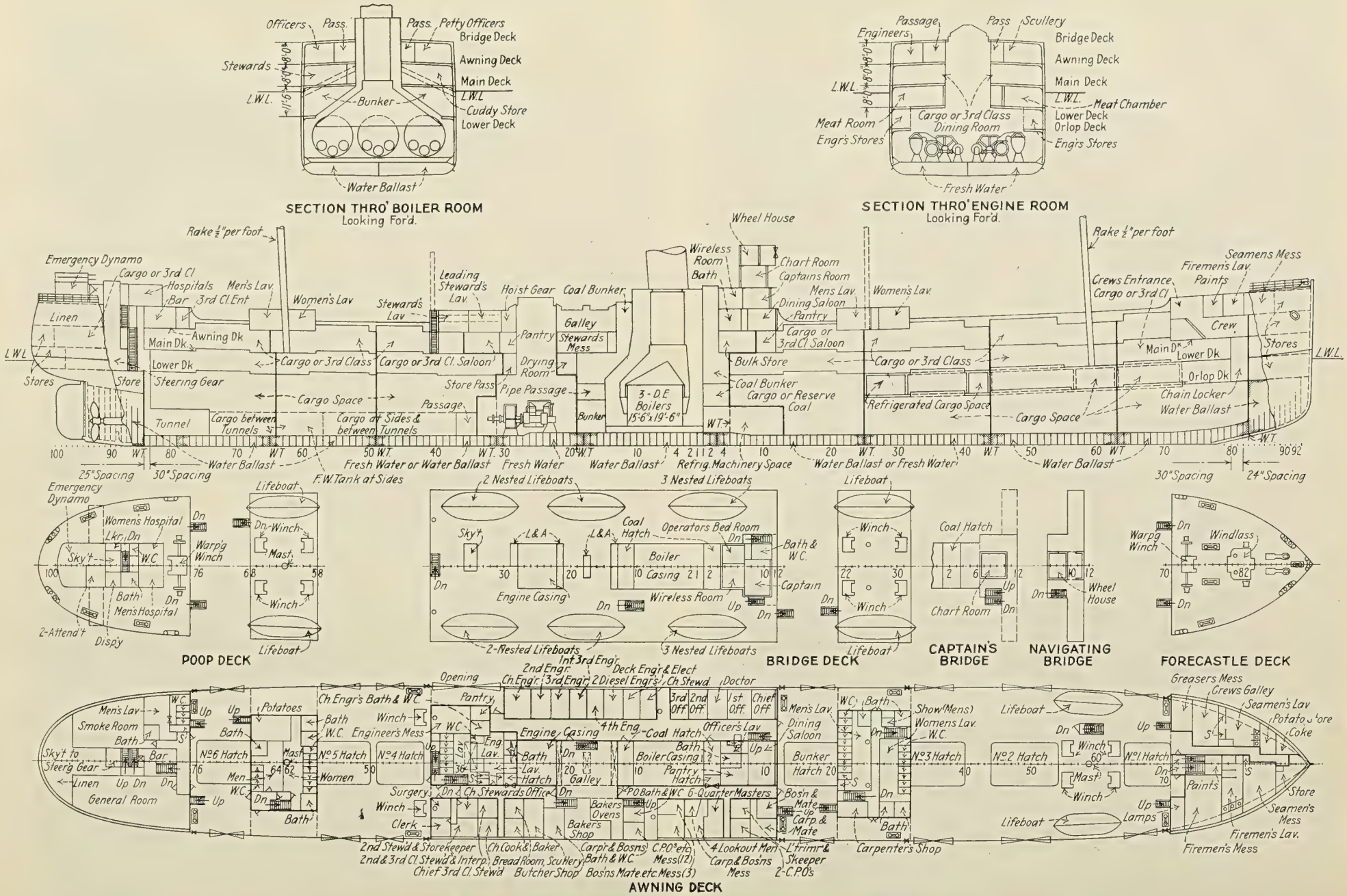


Fig. 5.—S. S. *Vedic*: Profile, Upper Deck Plans and Sections Through Machinery Space

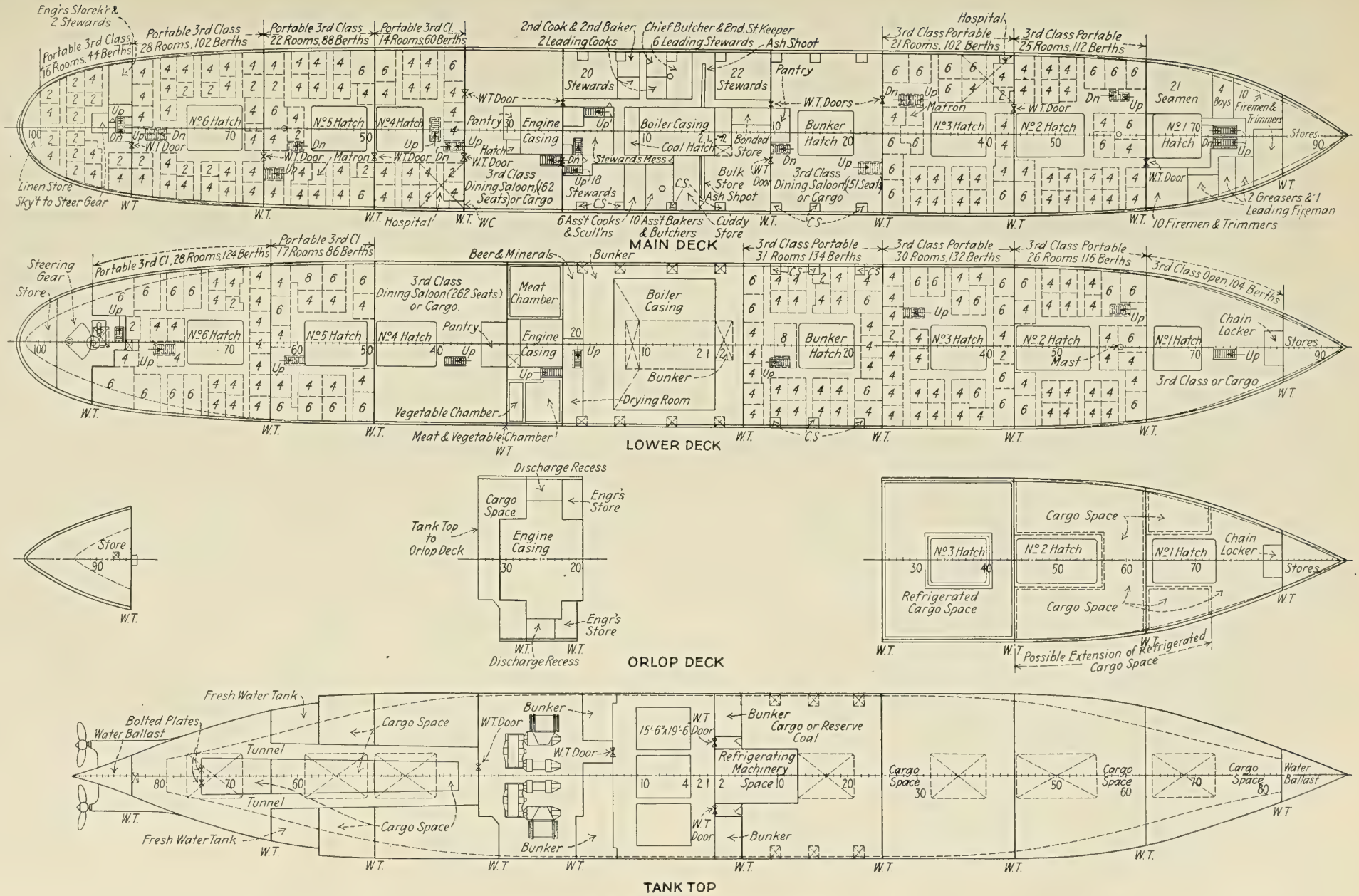


Fig. 6.—S. S. *Vedic:* Deck and Hold Plans

eleven compartments, and her bottom has liberal tankage for water ballast or fresh water, the fore and aft peaks being reserved for water ballast.

Propelling Machinery

The ship's power plant is a model of its kind, with two sets of geared turbines, each set consisting of a high and low pressure turbine with a single reduction gear. There are three large double-ended boilers. Her coal consumption is said to be moderate, and her speed better than 10 knots with power in reserve.

Accommodation

In the arrangement of her accommodation for officers and crew, the ship is very attractive. The captain's room, together with the wireless room, is situated on the bridge deck and the officers' and engineers' accommodations together with their dining saloon are situated on the awning deck. The two principal dining saloons for passengers are on the main deck, the smoking room and the general room are on the awning deck, and one dining room is on the lower deck.

One distinguishing feature of all these apartments is the woodwork, which is done in paneled oak. Quite in keeping with the general character of the rooms is the furniture. One is scarcely accustomed to seeing swivel chairs and small serving tables in third-class, for example, yet this ship's smoking room has both, while there is a perfectly appointed bar where the third-class passenger may "wet his whistle" quite as satisfactorily as any first-class or second-class passenger on the ocean greyhounds.

Staterooms

The ship's passenger capacity is 1,200, and she has a crew of 208.

The most striking feature of her sleeping quarters is the small staterooms with two berths. There are also a considerable number of four-berth rooms, and some containing six berths, but the dormitory, so well known in earlier third-class carriers, in which large numbers of passengers were bunked in open spaces, has been entirely eliminated.

The walls and ceilings of the staterooms are in white enamel, and each room is furnished with a high grade vitreous china bowl, with nickled fittings and neatly designed metal water tank. Each room is fitted with electric light, sanitary floor covering and indirect ventilation. The berth boards are polished hardwood, and each bed is furnished with a mattress, blanket, sanitary pillows with slips, and a bed spread on which is embroidered the house flag of the White Star Line.

Stateroom Walls Removable

One interesting feature in connection with the construction of these bedrooms is a system by which all the walls can quickly be taken down, as they are fitted in place by metal clamps interlocking with sockets on pipe stanchions.

The managers of the International Mercantile Marine Company of New York, of which the White Star Line is an important subsidiary, state that after four months of service the *Vedic* is rated as one of the most efficient vessels ever added to their fleet, which totals 106 vessels of more than 1,000,000 tons aggregate register.

Owing to her novelty, the *Vedic* has already attracted the attention of students of shipping. A magazine writer who recently crossed on her as a passenger, has this to say regarding the *Vedic's* accommodation, and the effect of the one class idea on passengers:

"The total absence of superior classes on board the *Vedic* is certainly not without its pleasant psychological effect. There is no one to look down curiously from a higher deck upon the strange denizens of the steerage, nor can first or second-class adventurers pass through the dining room to see "the animals feed." The ability to move about the ship produces a certain feeling of freedom not to be despised. In quantity and quality, the food has been quite as good as one could expect for the money. A chicken dinner we had on the two Sundays. Fresh fruit has been handed round at intervals.

"Capacious, comfortable and permanent social and smoking rooms occupy the entire stern portion of the *Vedic* on the main deck, garden-seating runs entirely around both and there are square tables with revolving chairs around them in each room. In the social room there is a piano. Both rooms have been kept clean and have been a distinct comfort to the passengers.

"One of the best things on the *Vedic* is the lavatory accommodation. Here in the past has been one of the great offenses of steerage travel. On the *Vedic* the lavatories are spacious, clean, light, well-painted, with tiled floors and due privacy. The wash basins are substantial affairs with running water and there is a bathroom supplied with hot and cold sea water. Mirrors are plentiful. In the cabin, stand wash-basins with individual supply tanks and waste basins are provided, also water bottle, glass and mirror."

The Availability of the Ex-German Ships

BY WILSON P. SMITH

The availability of the ex-German passenger ships for use in the American Merchant Marine is a timely topic at this particular period. With the Shipping Board's policy of allocating certain of these vessels to different operating companies, reconditioning is necessary to restore the ships to a suitable condition for competition with passenger liners of other nations. A close study of the German ships reveals a number of items of interest, a few of which are enumerated.

THE reported excessive reconditioning costs of the ex-German liners can be better understood after a careful study of the great amount of work necessary to restore these vessels. When they were interned and made ready for war service as troop transports, their interiors were, to a more or less extent, entirely cleaned out. It seems to have been the policy of the Government at the time to leave the public rooms and the upper deck first-class staterooms for officers' use. Invariably, the lower decks containing second and third cabin rooms were completely stripped, and the compartments used for open standee berthing of troops.

A very important item in the conversion of these ships into passenger liners is their speed. This must be reckoned with in determining the class of passengers desired to be carried. These ships vary in speed from 11 to 26 knots, and in age from 6 to 26 years. Prior to 1901, the fastest of these ships

was the *Aeolus,* ex-*Grosser Kurfurst,* designed for 15 knots. Following this came the greyhound type with varying speeds up to 23 knots. Included in this group are the *Von Steuben,* ex-*Kronprinz Wilhelm,* and the *Agamemnon,* ex-*Kaiser Wilhelm II.* The *Leviathan,* ex-*Vaterland,* was the latest development at 26.3 knots. These items must be gone into carefully by the ship operator before the reconditioning plans are worked out.

Structurally, the German ships are well built—the material appearing, when the sheathing is removed, in a wonderfully well preserved condition. Their type of construction differs materially from shipyard practice in America; their shapes are quite different, and their manner of securing continuity of strength far different from those employed in this country. Ridge bars are almost entirely lacking, and stanchions are placed directly on a steel deck, attaching to the deck beam overhead, no attempt apparently being made to register stanchions deck over deck.

The deck machinery is good, and usually massive. A number of very ingenious arrangements are employed, particularly in the detail of miscellaneous fittings.

Electric Wiring Out of Date

The electric wiring is entirely out of date, and in reconditioning a ship for passenger use it must be entirely rewired. Their single wire system—using the shell as a ground—together with their generators, which are invariably shunt wound and not parallel, offers a wholly impracticable proposition to retain as originally installed. The method of carrying the wiring throughout the ship is extremely bad, no effort whatever having been made properly to insulate it in passing over and through woodwork. As installed, it would be practically impossible to secure the necessary certificate of approval on this work.

The joiner work has been given most careful attention. In many instances it is a marvel in craftsmanship. The bulkheads generally are of panel construction with ventilating transoms along inboard bulkheads; doors with "*V*" louvres fitted in the lower panel are the best that can be desired for their particular purpose.

Decorations Far From Pleasing

In the attempt to decorate, the good impression of the joiner work, in many instances, was lost. At craftsmanship, the Germans are past masters, but as decorators the results are far from pleasing. Invariably some incongruous and meaningless plastic work is spread out promiscuously in panels, which would far better be left plain. In the interior design of their ships, the Germans were correct and appealing, probably, to the traveling public of their day. To the present day traveling public, they would receive only adverse criticism. The deck heights were low, and spacious rooms suffered from this lack of height. Bathing facilities were exceedingly limited and the use of folding wash cabinets general to a great extent.

In reconverting these ships to cater to the tastes of the cultivated American traveling public of today, very little of the stateroom arrangement existing can be utilized. This has been shown conclusively in the ships reconditioned up to this time—the *Huron, Callao* and *Aeolus,* for example. The public of today demands greater bathing facilities and numerous private baths, in addition to running water in all staterooms.

Plumbing Unsanitary and Faulty

The plumbing on the German ships is probably the most offensive feature of all. The fixtures are not sanitary and are of poor design, the material in most cases being excellent. With the continental idea of bathing necessitating a full length tub, those fitted on the German ships, to an American, seem preposterous. By actual measurement it has been shown that the German tub requires exactly twice the quantity of water required by an approved American tub. The lavatories in the better ships are a very excellent grade glass fixture, but unsatisfactory from a sanitary standpoint, in that they are in three pieces and not integral.

The furniture available from these ships is of the highest order, though some very crude designs appear among them. With minor reconditioning and new upholstering, a large percentage of furniture can be salvaged. The German springs for berths were another of their ingenious fittings, and are today unsurpassed for comfort at sea.

In floor tiling, the Germans have produced and laid in an excellent way a very high grade of floor covering, in many instances original tiling remaining in first-class condition after 8 or 10 years' hard use.

Service Arrangements Well Planned

The service departments were highly developed and their galleys, pantries and bars were exponents of the very best for the quick and constant service demanded on liners.

The main engines and auxiliaries varied in type with the age of the ship, and are usually found to be quite efficient though rather heavy and crude in design. Cold storage compartments on the larger ships were excellently constructed, but as the grade of the ship was lessened, so was the completeness of this important section of the ship's service curtailed.

American vs. German Passenger Requirements

American practice and regulations of today differ widely from the German of the period when these vessels were designed. The American ship must give more superficial feet to third-class passengers, with a consequent reduction of passengers of this class carried. The loss is nearly 20 percent, with a corresponding falling off in revenue. American ships must carry a much larger crew, and berth them with more deck area per man. This must necessarily invade the original passenger sections and again reduce the already lessened passenger list. From this it can easily be seen that the criticism of reconditioning at excessive cost for an actual loss of passengers is not all the fault of the re-designing architects, but is caused by regulations to which they must adhere in allocating space.

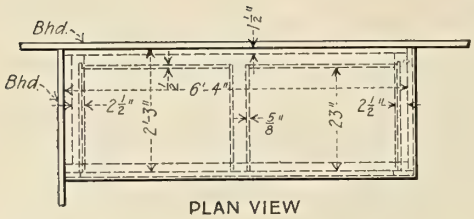
Taking all in all, the ex-German ship is not readily adaptable to an American express liner use, because of the many features lacking in her design which must be supplied to create an acceptable ship. The companies to which these vessels are allocated must spend an apparently large amount of money in restoring the ships to the use for which they are desired, involving expenditures which it is difficult for the landsman to understand.

Magnesite Composition Decking on Combination Passenger and Cargo Vessels

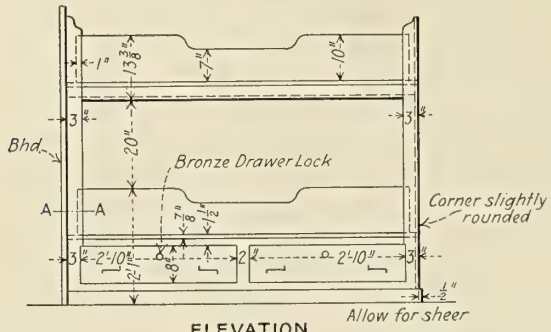
In the description of the *Hawkeye State* published in the March issue of Marine Engineering the subject of deck covering, a very important item on passengr ships, was overlooked. Two of the five passenger ships built and building at the Sparrows Point yard of the Bethlehem Shipbuilding Company have had their decks, with the exception of the dining rooms and passageways, covered with Litosilo manufactured by the Marine Decking & Supply Company, Philadelphia, Pa. On the three remaining ships Litosilo will be used throughout. On nine of the passenger vessels built and building at the New York Shipbuilding Corporation, with the exception of the first ship, on which cement was laid in the passageways, Litosilo is used throughout. The same is true of two combination passenger and cargo vessels building at the Newport News Shipbuilding & Dry Dock Company. In the passageways and public spaces of the ship Litosilo is usually covered with a composition or rubber tile and in staterooms it may be partly covered with rugs.

Ship Joiner Plans

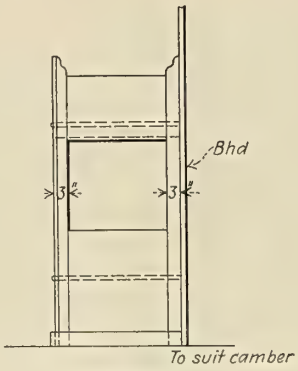
Built-in Berths



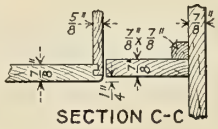
PLAN VIEW



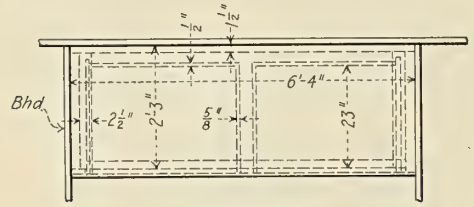
ELEVATION
TYPE A
One End Open



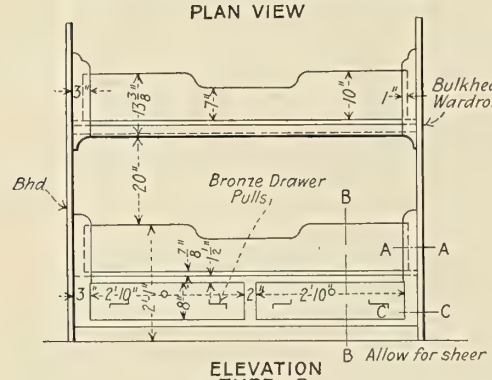
END VIEW



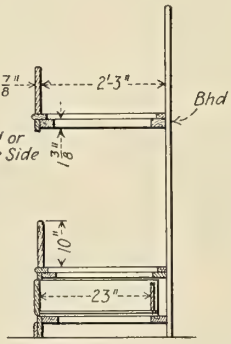
SECTION C-C



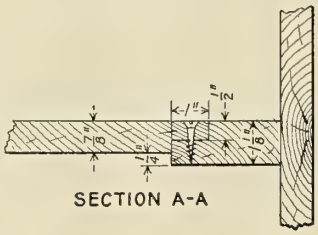
PLAN VIEW



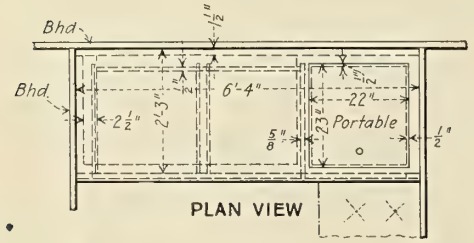
ELEVATION
TYPE B
Both Ends Closed



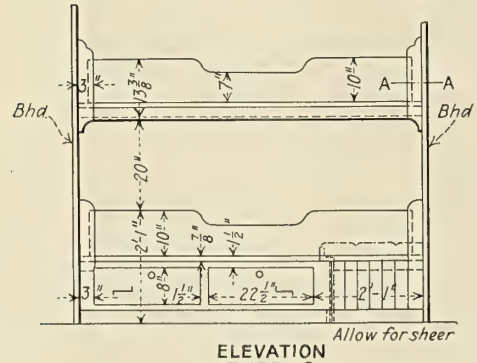
SECTION



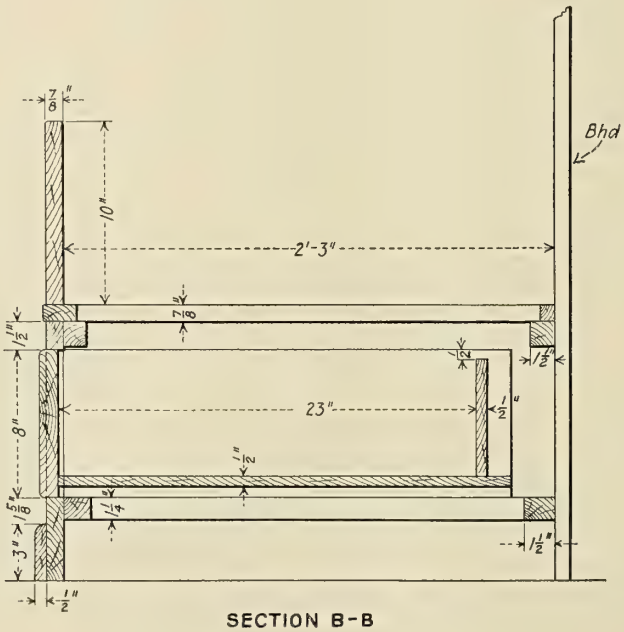
SECTION A-A



PLAN VIEW



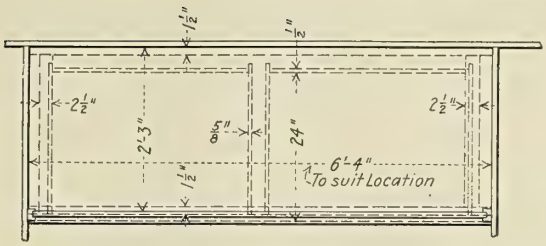
ELEVATION
TYPE C
With Transom



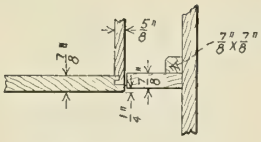
SECTION B-B

Ship Joiner Plans

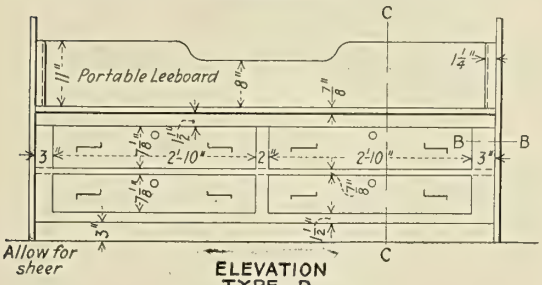
Built-in Berths



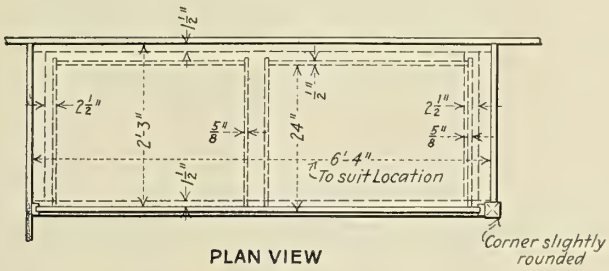
PLAN VIEW



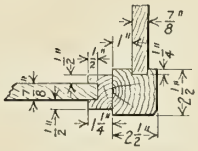
SECTION B-B



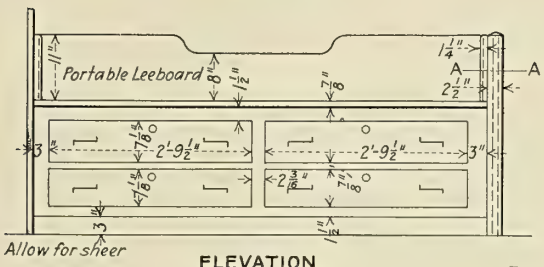
ELEVATION
TYPE D
Both Ends Closed By Bhd. or Wardrobe.



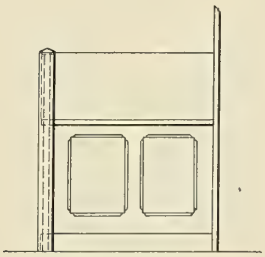
PLAN VIEW



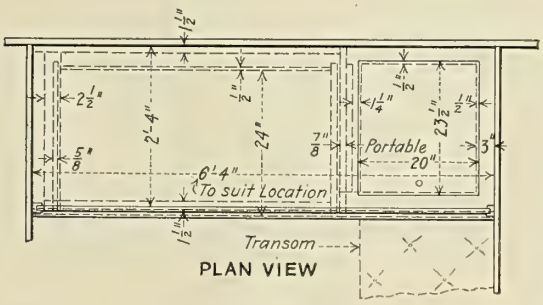
SECTION A-A



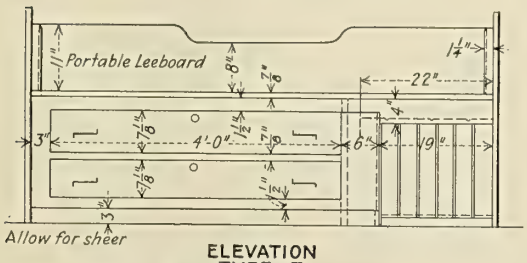
ELEVATION
TYPE E
One End of Berth Open



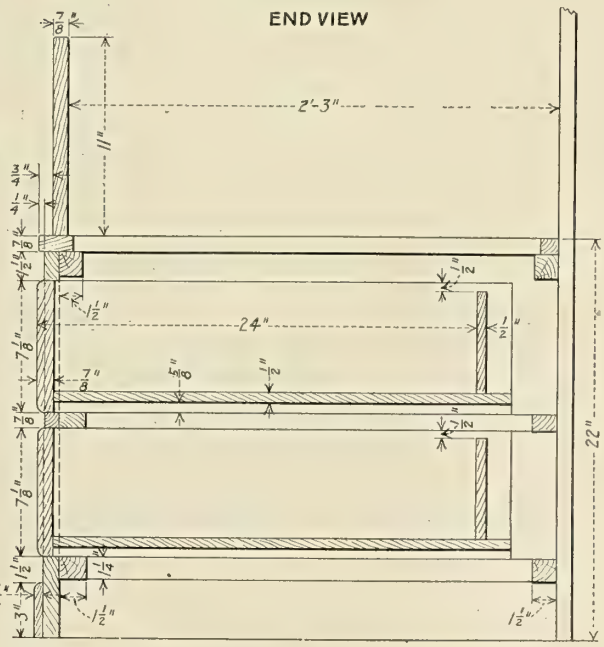
END VIEW



PLAN VIEW



ELEVATION
TYPE F
Both Ends Closed By Bhds. and Transom Fitted.



SECTION C-C

Heavy Claims Against the Government Held by Shipbuilders and Shipping Interests

By Waldon Fawcett

Not the least of the responsibilities facing the new executive administration at Washington and the new Congress of the United States is that involved in the adjustment and settlement of the claims of shipping and shipbuilding interests. Irrespective of what policy may be worked out for the future operation of the government's merchant fleet, and irrespective likewise of whether the present Shipping Board organization shall survive or be supplanted by a new managerial agency, there looms the obligation to dispose of a formidable aggregate of claims that have grown out of the construction and operation of the war-inspired merchant fleet.

AMONG some persons in maritime circles, as well as outside, there has been an impression that the only obligations in this quarter on which Uncle Sam has been *slow pay* are the claims of the wooden shipbuilders. This estimate of the situation falls short of the facts. Tardiness in making final payments to the wooden shipbuilders has stirred feelings of sympathy, to be sure, partly, no doubt, because many of the claimants are operators of comparatively limited resources who are inconvenienced by the delay. But in terms of dollars, the aggregate of the claims of the wooden shipbuilders is overshadowed by the sum of other claims that remain to be disposed of, ere the governmental shipping enterprise may be said to have attained a definite or permanent status.

According to the latest information available to the General Comptroller of the Shipping Board and his assistants there are on record or "on the way" claims aggregating about $147,000,000. This total includes the claims for just compensation for ships requisitioned during the war. The officials figure that they will require $25,000,000 to pay the claims that are due, as it were, before the close of the present fiscal year on June 30, 1921, and that not less than $25,000,000 will be needed for the payments to be met during the twelve months beginning July 1, 1921.

Claims for Requisitioned Ships

Particularly significant, in the immediate situation, is the factor supplied by the claims for requisitioned ships which foot up $45,189,000. On the part of the officials of the Shipping Board, Emergency Fleet Corporation there is a disposition to, sentimentally, regard these claims as settled because definite awards have been made. But the awards, save in a small proportion of cases, have not been accepted by the claimants, which circumstance reveals the element of dispute or controversy that must be reckoned with in considering the situation as to claims and that will probably result in legal contests that are likely to drag their weary course through the Federal courts for years to come—a heritage of the war similar to that which came, it will be recalled, from the Spanish-American war.

The situation with respect to compensation for the former owners of requisitioned ships may best be indicated, perhaps, by stating that the awards made against the aggregate of $45,000,000 in claims aggregate to date $16,434,000. Payment has been made to the amount of only $2,459,000, leaving more than $13,000,000 of approved payments yet to be made. Inasmuch as the claimants have not accepted the awards represented by the amount last mentioned it is, of course, impossible to declare even this portion of the transaction a closed incident.

Uncertain Status of Claims

Chaotic is too strong a term to apply to the situation with respect to shipping and shipbuilding claims but certainly the current status is one of pronounced uncertainty. To begin with, there is the circumstance that different kinds of claims —cancellation claims, contract claims, etc.—are so interwoven that detailed appraisal is almost impossible. Added to that is the impossibility of figuring on any hard and fast rules or percentages for settlements. Commenting recently to the effect that a claim for, say, $6,000,000 was likely to be settled ultimately for $1,000,000, Commander Gatewood remarked that it was impossible for any persons to estimate into what terms of cash payment the $147,000,000 in listed claims will ultimately be translated.

The more of conjecture and less of substance there is at this stage comes from the fact that by no means are all the claims yet in. The General Comptroller said the other day that he knew of $31,000,000 in claims that have not as yet so much as been placed on file. The claims of the shipbuilders in particular are incomplete. The attitude of the Shipping Board officials is that the shipbuilders, generally speaking, have built up their cancellation claims as high as they can and that on general principles these amounts must be reduced before settlement can be sanctioned.

Extent of Government Liability

During the past few months there has been considerable discussion and some difference of opinion as to the extent to which the liability of the government was fixed in the cancellation of shipbuilding contracts where work had been commenced or material purchased. Such contracts were, following the signing of the armistice, summarily canceled by wire and then confirmed by letter. The contractor was then expected to put in his claim for the amount of money already expended for labor and material and to cover commitments. The occasion for negotiation with respect to these shipbuilding claims has been found not so much in tangible items of ascertainable proportions as in the claims for sacrifice of less obvious dimensions such as the loss of anticipated profits and the disruption of plant routine due to the sudden termination of the contract. The Shipping Board is unwilling under any circumstances, it might be added, to allow claims for *anticipated profits* but the mere presence of such items in claims operates to render tedious the process of adjustment.

Completion of Government Vessels

A very interesting side-light was thrown recently upon the situation with respect to shipbuilding claims when the committee on appropriations of the House of Representatives considered the feasibility of practicing economy by delaying the completion of new vessels, building on the cost-plus basis, through the simple process of withholding appropriations. Director of Construction Gatewood opposed this policy as calculated to bring down upon the head of Uncle Sam a considerable addition to the already heavy load of shipbuilding claims.

The head of the construction department told the Congressional committee that if anything was done to interrupt the normal progress of the building program, on either the cost-plus or lump-sum basis, the sequel would be found in the submission of additional claims for damages. He ventured the opinion that a shipbuilder whose operations were interrupted by the government "would have a good claim." The chairman of the Congressional committee thought that the limit of a shipbuilder's claim under such circumstances would be a sum equivalent to 6 percent interest on the invested money tied up but Commander Gatewood disabused his mind with the explanation that with a ship under construction, just as with a building half completed, sudden stoppage of work would warrant a heavy claim for damages because of the overhead involved, the disruption of the organization, etc., etc.

Reinstated Contracts

Shipping Board officials have, in this same connection, strongly dissuaded an element in Congress that would fain reopen the subject of the vessel construction contracts that are now being carried out in lieu of cancellations. Practically every vessel now under construction for the Shipping Board represents a new transaction in lieu of a cancellation—a ship *reinstated* to agree with a claim already adjusted with the shipbuilder or contractor. To illustrate the situation it may be related that one shipbuilding concern said: "If you will give us three ships out of the ten you originally promised us, we will settle for so much." That attitude has been the attitude of a majority of shipbuilders, with the result that a great number of compensating contracts are now under way.

Some Congressmen, who feel that the government would have saved money if it had canceled all contracts and made the best settlement it could, have in deliberations over future appropriations been flirting with the idea of curtailing obligations in this quarter. Commander Gatewood has served warning that, if the settlements or compromises made are opened up, the action will bring in its train a new crop of claims in addition to the claims that would grow out of the stoppage of work. The contention of the Shipping Board executives is that the commitments for materials were so heavy in the case of the average group of vessels affected by compromise that it was obviously the part of wisdom for the government to follow through with a curtailed construction program in order to get its money back rather than to make a settlement that would involve the complete abandonment of the material on hand.

Payment of Claims

Not only is the adjustment of claims proceeding with deliberation but the actual payment of claims—even in the instances where shipbuilders or vessel owners are prompt in acceptance of propositions made to them—do not keep pace with awards. This is due to the fact that there is involved a considerable amount of detail that cannot be denounced as mere "red tape." For example, after the claims board has passed upon a claim award there remains the necessity of ascertaining what advances have actually been made to the contractors. This last constitutes, indeed, a phase of Shipping Board operations the magnitude of which is not fully appreciated even within the industry. The long time loans made to shipbuilders by the Shipping Board and covered by mortgages running from 1921 to 1930 amount to more than $21,000,000.

The machinery for the adjustment and settlement of claims against the Shipping Board is contained in the Claims Board, which is of comparatively recent origin and which is made up of four members, some of them qualified by long connection with the Shipping Board whereas others have had practical experience in private shipbuilding. The operation of the Claims Board entails an expense of about $200,000 a year and presumably will not continue for more than a couple of years or so, inasmuch as claims that cannot be disposed of by this agency within a reasonable time will undoubtedly go to the Court of Claims.

Procedure of Claims Board

The simple procedure is for the Claims Board, after the requisite survey and first-hand negotiations with the shipbuilder or contractor involved, to pass a resolution settling the specified claim by award of a fixed sum of money. However, considerations other than cash are apt to enter into the settlement of a claim. Notably there is the question of salvage. Instead of taking over all of the accumulated materials or salvage, the Shipping Board frequently offsets a claim by turning over the materials to the contractor in part settlement of his claim. To determine the loss sustained and the allowances to be made under such circumstances it is necessary, of course, to compute the cost price of hundreds or perhaps thousands of material items. In due process the Claims Board passes a resolution reciting that the stipulated claim is settled for a certain cash payment, plus the material in the shipyard which represents expenditure in an acknowledged sum. In that form the award goes to the General Comptroller.

Anticipated Profits

In order to emphasize a point that seems to have been the subject of misunderstanding in shipbuilding circles it may be reiterated that it is not the policy of the Claims Board to make any allowance in settling a claim for prospective or anticipated profit. A reasonable profit is, however, presumed to be conceded on the work done by a shipbuilder or other contractor up to the time of the cancellation of the contract. Where material has been purchased, as has been the case in virtually all contracts that are subject to adjustment, it is customary for the Claims Board to allow a handling charge that is understood to run about 6 percent, on the average. Naturally, however, there can be no uniform allowance for this service inasmuch as there is variation—in the cases of different shipbuilders in the work and expense involved in the delivery, storage and insurance of accumulated material.

The estimates of claims in the shipping and shipbuilding undertaking that have been supplied to Congress in the spring of 1921 do not attempt to make calculation of the amount of money that will be required for the wooden ship amortization. The issue of the claims of the wooden shipbuilders was first taken up by Congress more than a year ago but there persists a sharp division of opinion as to the amount of responsibility involved. Officials of the Shipping Board have all along contended that there is nothing in the records that officially commits the Shipping Board or the Emergency Fleet Corporation to obligations through the equipment of shipyards or the construction of vessels other than those fixed in the contracts entered into.

Three Types of Claims

Tersely, then, the attitude at the Shipping Board is that all the claims of the wooden shipbuilders divide themselves into three classes. In the first class are the claims for compensation for work performed and material furnished. In the second class are the claims for legal damages growing out of contracts that were canceled—claims on a par, that is to say, with most of the claims in the steel shipbuilding field as above discussed. In the case of both these classes of claims there is, as it is represented, no difficulty except that of agreeing upon the amount to be allowed in each individual case. The third class of claims, however, is of a character that involves the controversial element. They are based upon assurances which wooden shipbuilders say they received from representatives of the Shipping Board but which took the form of oral promises or other informal commitments rather than contracts duly signed and sealed. All the wooden shipbuilders who have claims of this type feel that they were as-

sured a much larger volume of work than they received from the Shipping Board. Some of the builders had the distinct impression, as the result of their negotiations with representatives of the government, that they were to have at least three turns of the ways.

Lump Sum to Cost-Plus Basis

Most of the contracts held by wooden shipbuilders were originally lump-sum contracts—that is contracts that, in each instance, fixed a definite sum for a definite amount of work. It was ascertained as the shipbuilding program progressed, however, that the amounts that had been fixed were, in many instances, too small. There were delays also in getting materials and the changes made in the plans of the ships likewise counseled some more equitable basis of compensation. Consequently the Shipping Board in a number of instances, where application was made, changed the contracts from a lump-sum to a cost-plus basis, but in most instances fixed a definite fee to be paid for profit and amortization. The payment of those fees, calculated on the amount of work actually performed has, in no instance, however, proved sufficient to even approximately amortize the cost of the shipyard or to make the shipbuilder whole. In the field of wooden ship construction, in contrast to the steel shipbuilding situation, the basic question at issue has been whether the government should amortize the shipyards.

Norwegian Ship Claims

An interesting phase of the claims situation has to do with the Norwegian ship claims, passing mention of which was made in the report submitted in March by Chairman Walsh of the select committee of the House of Representatives on Shipping Board operations. The investigating committee notes the division of opinion among persons who considered the claims of the several Norwegian owners, known as the *stray* group whose vessels were requisitioned under authority of the President. Involved in this aspect of the claims situation are five principles as follows: (1) that the vessels on the stocks and materials for their building were taken and not the contracts; (2) that the contracts were taken over as well as the vessels on the stocks and the material for their building; (3) that a treaty was violated in the taking of either the physical property or the contracts; (4) that the treaty was not violated in that an act of Congress signed by the President abrogated the treaty; (5) that the assignability of the contracts is involved as to the rights of persons who purchased from the original owner under the terms of the building contract. The award made to the *stray* group was $34,500,000 and the Congressional committee expresses no opinion as to the merits of the claims and the settlements, because the settlement of similar claims has been taken up with the State Department in a request for arbitration.

Catch the Bees

Consider the B. T. U.'s and How They Escape! A Chance to Cut Down Fuel Bills and Keep Up Wages

By "Old Scotch"

THE ordinary, garden and field type of bee is the symbol of work, due to his indefatigable habits of industry when the sun is shining, and his forehandedness in laying by his food for the period when, due to climatic conditions, he can no longer work at his chosen job of extracting saccharine matter from clover and other flowering plants. Hence there are many qualifications of the bee which can well be emulated by mankind and especially that portion of the race which goes down to the sea in ships.

There are bees by the millions on shipboard, and it is the training of these and their proper utilization which form or should form the principal occupation of marine engineers. The bees I have reference to are not those of the gaudy wings and the merry buzz, but as workers they have the honey gatherers backed off the map.

The Marine Bees

This marine type however, unlike their cousins on land, are not so tractable and instead of following their leaders and driving along in swarms, they have a faculty of breaking away from the procession at every turn in the road and dissipating their energy in useless endeavors. Those of you who have heard Frank Bacon in "Lightnin'" tell of how he was the first man ever to drive a swarm of bees across the plains can well appreciate how much more difficult it would have been for that dear old prevaricator to have driven a swarm of these marine bees when I tell you that the bees I have reference to are the B. T. U.'s liberated in the furnaces of the ships' boilers due to the union of the carbon in the coal or fuel oil and the oxygen in the atmosphere. As soon as these bees are formed they immediately try to make their escape in the paths easiest for them to make their getaway. Holding them together and making them work is the task set for the firemen and engineers.

There are 14,000 of these little workers in every pound of good coal, and over 19,000 in every pound of good oil: in these days of high fuel costs every B. T. U. possible should be caught and made to do some good, honest work. We all know, of course, that in spite of precautions some eighty or ninety percent of them get away without doing anything worth while, so there is a very large field in which engineers can operate in this game of bee catching.

The Bees That Escape

Assuming that the engineer's crew on a merchant cargo vessel receives fifty percent of the total money paid for wages and overtime, the figures recently given out by the Shipping Board as to the relative costs of different essentials of ship operation will show that the average cost of fuel is just about seven times the cost of labor for the engineer's force.

As fuel is such a large portion of the cost of operation, and as the efficiency of the engineer determines to a great extent the amount of fuel used, it can readily be seen how important it is to the shipowner and to the entire merchant marine that every means be taken to improve the efficiency of the men who hold such responsible positions on the ships.

Chances for Savings on Board Ship

It cannot be said even by the most radical labor advocate that American marine engineers are not well paid at the present scale of wages. The tendency of the period of deflation upon which we are now well advanced is for a general reduction of wages in all branches of industry. Already this reduction has struck the shipyards to the tune of from ten to fifteen percent, notwithstanding the fact that the efficiency of the average shipyard mechanic has vastly increased within the past two years following the Armistice.

The opportunity for increased efficiency on shore is not

comparable with the chance for savings on board ship. If marine engineers and firemen wish to stave off what appears to be an inevitable reduction in their wages, they must immediately take steps to improve their efficiency. A 10 percent saving in the amount of fuel consumed and at least fifty percent reduction in the cost of repairs are well within the possibilities, and a quick demonstration of such ability ought to do much in influencing the average steamship owner and operator to defer wage reductions.

Engineers quite generally admit that they cannot much longer insist on being paid for overtime. They may as well realize that they will have to begin at once to return to old-time conditions of doing many of their own repairs. The proverbial "stitch in time" is very applicable to marine engineering, as the fitting of a new stud, the stopping of the smallest leaks ofttimes forestall the necessity for extensive repairs when the ship reaches port. The owners can help out in repair reforms very much by fitting a few well selected machine tools, such as a small lathe, a shaping machine and a drill press. It is surprising how many machinery repairs can be made on board, and while the ship is under way, by the engine room force, if they only have the will to make them.

The Waste of Fuel

The use or rather waste of fuel is the matter that needs the most attention from the operating force in the engine and firerooms. As before stated the B. T. U.'s once released have a faculty of running away from useful work, and it is in corraling them that the engineer must devote the best of his abilities. It is much easier for B. T. U.'s to escape up the stack then it is to penetrate dirty boiler tubes and get into the water where they can turn it into steam. Even a sixteenth of an inch of scale or soot on the tubes makes a difference of eight or ten percent in the efficiency of the boiler: hence they should be kept as clean as possible. Improper firing of coal or mixing of air and oil produces horrible waste of fuel, therefore the engineer in charge of the watch should devote himself to studying the best methods of using the coal or oil, and train his firemen accordingly.

It is less work to fire properly than improperly. In charging coal furnaces, the firemen must be quick and snappy, so as to keep the doors open the least possible time. Furnaces should be fired systematically, so that not more than one door is open at a time. Furnaces should not be choked with "crown sheeters," as a stuffed furnace is as bad as a stuffed stomach in a human being. Poor combustion is one result, and a stomach ache the other. Too much oil or too little air results in a bad mixture, and unconsumed oil or smoke results. Black smoke from the stack is a sign of a careless fireman, and a sure way of having wages reduced when the fuel bill reaches the office.

Unlagged Boiler Surfaces

Every little weep or hiss of escaping steam in the boilers, piping or engines means the chuckle of some truant B. T. U.'s who are escaping work. Unlagged boiler surfaces or portions of valves and piping make easy exits for more recalcitrant heat units. It is queer how many shipbuilders and superintendents overlook the possibility of cutting down waste by lagging the bottoms of Scotch boilers. They seem to go on the theory that "Oh well! what's the good of trying to keep them warm! ! And then they wonder why their boilers leak so badly in the shell seams. Think of a thick steel plate at a temperature of 400 degrees on top and about 100 degrees on the bottom. Do you blame them for weeping?

To accomplish most in the saving of B. T. U.'s I would advise all engineers to get acquainted with the alphabetic symbol, in the person of our old combustion friend, Mr. CO_2. That's what the chemist calls it, but ordinarily he is known as carbon dioxide, that is one atom of carbon makes love to and marries two atoms of oxygen. Mr. Carbon is somewhat of a Mormon in this affinity but he is much more efficacious in producing good boiler results than he is in a monogamous state, when he runs away with a single atom of oxygen. The best results of combustion are obtained when the escaping flue gases contain as nearly 14 percent of CO_2 as it is possible by correct firing to obtain. In ordinary, careless methods of mixing fuel and air, you are liable to get a mixture containing as low as 9 or 10 percent of carbon dioxide, which means right off a wasting of from 20 to 30 percent of the fuel up the stack.

Naturally chemists and combustion engineers know of these results, but their knowledge does not have any good effect in saving fuel on board ships, unless the men in charge know of and apply this knowledge. Not so long ago it was deemed impracticable to make chemical tests on board ship to determine the composition of flue gases. In stationary boiler plants it has for some time been customary among the more up-to-date engineers to have such tests made and to rate the firemen's efficiency on the way he kept up the proper proportion of carbon and oxygen in the flue gases. Quite recently several manufacturers have designed apparatus, at comparatively low costs, which can be fitted on marine boilers, so that even the uninitiated may read the CO_2 contents as readily as they can a steam gage.

The closing advice to my marine engineer brethren is to get next to some apparatus of this kind and start out on a hunt to arrest these perambulating B. T. U.'s and thus cut down their fuel bills and help to keep up their wages, for which they have my best wishes.

New Passenger Ship for French Line

THE *Lamoriciere,* which has been constructed for the Compagnie Genérale Transatlantique by Swan, Hunter, & Wigham Richardson Limited, at their Neptune Works, Newcastle-on-Tyne, has just completed her official trials and has been handed over to her owners, so that she may take her place in their mail and passenger service in the Mediterranean. The vessel is built of steel, about 385 feet in length by 50 feet beam, and has been constructed to attain the highest class in the Register of the Bureau Veritas for special service in the Mediterranean with the special mark for watertight subdivision.

Her passenger accommodation is extensive, very comfortable and even luxurious. She is fitted to carry 132 first class passengers, including two cabins-de-luxe suites, the accommodation including a spacious smoking room and conversation room on the boat deck, large dining saloon on the upper deck, and staterooms for one, two and three passengers on the promenade deck and upper deck. The decoration of all these rooms is of the highest type.

The second class passengers, 116 in number, have a well finished smoking room and music room on the promenade deck, a dining saloon on the upper deck and staterooms on the main deck. The third class passengers, 132 in number, have a comfortable dining saloon on the upper deck, while their sleeping accommodation is on the main deck. The lower deck is fitted for the carriage of cargo or soldiers.

The triple screw propelling machinery, which has been constructed by Swan, Hunter & Wigham Richardson Limited, at their Neptune Works, consists of one four-crank triple expansion reciprocating engine, balanced on the builders' well-known Yarrow, Schlick & Tweedy system, and two low pressure turbines of the Parsons type, in conjunction with single reduction mechanical gear. The center propeller is driven by the reciprocating engine and the wing propellers by the turbines. Steam is supplied by six single-ended boilers working under Howden's system of forced draft, and arranged to burn either coal or oil fuel.

On the trial trips the machinery worked without the slightest hitch, driving the vessel at a speed of 18½ knots.

Locks of New Orleans Industrial Canal Controlled by Novel Electrical Switchboard

An electrical switchboard for controlling the locks of the Inner Harbor Navigation Canal at New Orleans, which is a representation of the actual canal in miniature, has just been designed and built by the General Electric Company. This system, patterned closely after the central boards built for the Panama Canal by the General Electric Company, enables one man as operator, quite out of sight of the canal itself, to control the movements of the lock machinery and see before his eyes just what is happening on the actual canal when he turns the control handles.

Control Board

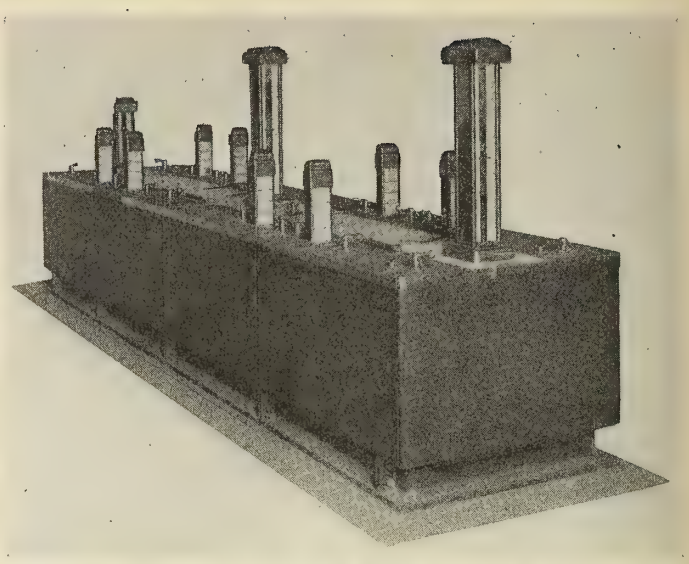
The miniature canal, or control board, is 16½ feet in length and is rated at 110-220 volts alternating current. The switchboard shows the lock chambers of the canal by a stretch of marble slabs, extending from one end to the other of the control board. At various points along the line of this miniature canal, columns rise to various heights. These columns are scaled for reading, and indicate the rise and fall of water in the lock chambers when the operator, by means of the control handles, opens and closes the water gates in the actual canal.

On the top and near the edges of the board are located the control handles. These handles are operated through an angle of 90 degrees. They open and close the circuits to the electrical apparatus which works the lock machinery, located in the walls of the locks. Name plates show the "open," "close," and "off" positions of the handles.

Interlocking Arrangement

A special arrangement was worked out to take care of the question of interlocking. A series of vertical and horizontal bars is provided, which move in a direction 90 degrees apart. The bars are provided with bevelled stops, known as "dogs," designed to engage one another. When these dogs meet, it is impossible to move one bar until the turning of a control handle has lifted the dog out of the way. Other control handles meanwhile are locked out of action. The Sylsyn system is used as the medium of indication between the lock machinery and the switchboard.

The canal to be controlled by this system will connect the Mississippi river with Lake Pontchartrain and will eventually provide a shorter water route from New Orleans to the Gulf of Mexico. It extends completely across the city of New Orleans for 5½ miles. The Inner Harbor itself will be at the level of the Gulf of Mexico, and subject only to tidal fluctuation of the gulf.



Lock Control Board, 110-220 Volts, A. C. (End View), Port Commission of New Orleans

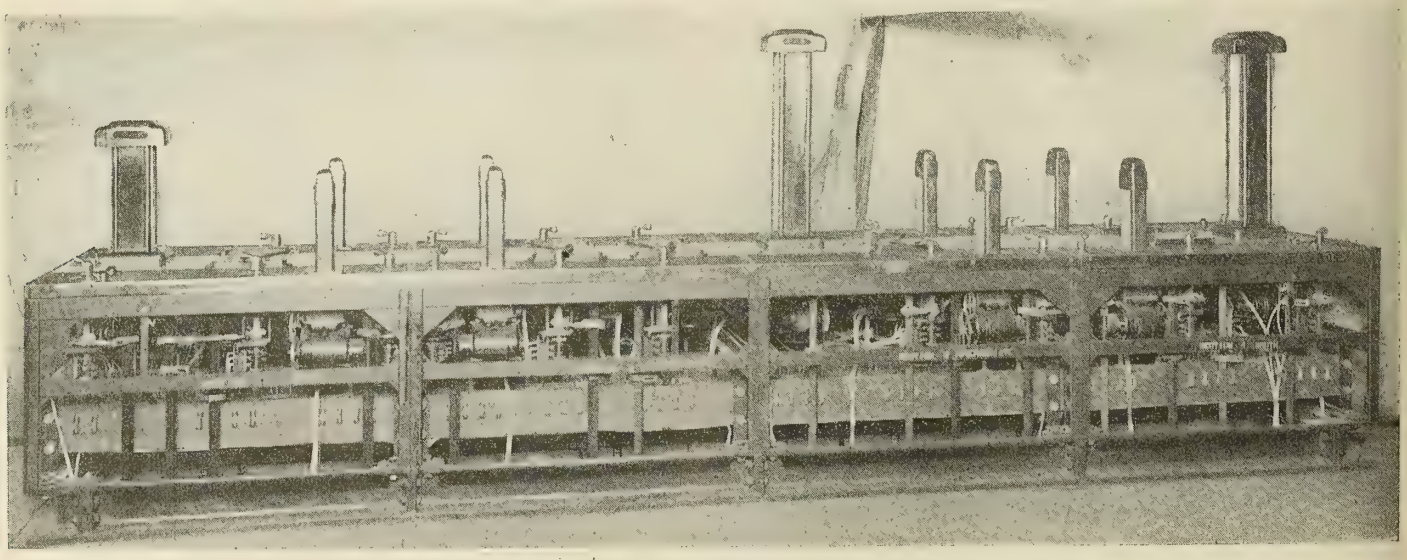
Concrete Ship Lock

The chief feature of the canal, which will allow for the passage of vessels from the outer harbor, on the Misissippi, into the inner harbor, is a large ship lock of reinforced concrete, which will accommodate a ship up to approximately 20,000 tons. The lock masonry will have a length of 1,050 feet and a usable length of 640 feet; a clear width of 75 feet, and a depth over the sill at low water in the gulf of 30 feet.

The development of the inner harbor provides an addition of approximately eleven miles of waterfront to the port of New Orleans. The work as a whole is about 80 percent complete. It is expected the entire project will be complete and ready for opening to commerce about next July.

This project, when finished, will constitute a link in the great intracoastal canal, which will provide a continuous inland waterway from Boston to Brownsville, Texas. It will form the waterway of least resistance to New Orleans from the Alabama coal fields.

The control board described above will be the first of its kind installed in the United States and the only one outside the Panama canal zone.



Lock Control Board, 110-220 Volts, A. C. (Side View With Covers Removed), Port Commission of New Orleans

Financing Our Foreign Trade*

Provision for Long-Term Credits Necessary so That the World Can Do Business With Us

BY GEORGE ED. SMITH**

THE business men of the country have watched and waited for more than two years, while the time has arrived when it has been necessary to provide some means for preventing the complete disruption of our export trade. Since the armistice a $4,000,000,000 trade balance has piled up, and now a further balance finds difficulty in being financed. The National Chamber of Commerce, the National Foreign Trade Council, the National Association of Manufacturers, all agreed long ago that something should be done to solve this great problem. The opportunity came when Congress passed the "Edge Act," and when a committee of the American Bankers' Association formed the plans for the Foreign Trade Financing Corporation, which by its very size and its nationally representative character, is expected to make real headway in remedying the chief obstacle now in the path of American exporters.

Foreign buyers need American goods more than ever; American manufacturers, business men and farmers need more than ever to supply what the foreigner wants. They have the demand. We have the goods. By supplying that demand we could get rid of that great surplus, could keep busy six days a week instead of four, and could pave the way toward a new position for the United States in the international commerce of the world.

> The solution of American labor's greatest problem—unemployment—is the exporting of American time sheets to bring back American payrolls. The products of American workmanship under our present credit system can only go part of the way in reaching the foreign buyer. To reach the foreign buyer, to keep American goods flowing, American industries running, and to bring back work for the four million pairs of American idle hands, there must be provided at once adequate machinery for granting long-term credits in our export trade. Until these long-term credits are available, American cargoes will be halted in mid-ocean, caravans loaded with American goods will be stopped in the middle of their journeys, and a great barrier will remain in place in all parts of the world, checking the flow of American time sheets for the solution of filling American payrolls.

Why can't this be done now?

Because the commercial banks of the United States cannot go on extending long-term loans, and further, because the American dollar is at such a high premium in foreign countries that foreign buyers cannot afford to do business with us on the short-term basis, customary in this country. In granting short-term credits the limit has about been reached. It is only by giving the foreign buyer more time in which to pay for his goods that we can compete successfully with the rest of the world and sell our surplus products abroad.

Now, what is the reason for this four-billion dollar trade balance, and why is it threatening to put us out of business with the rest of the world?

Foreign buyers since the armistice piled up this four-billion dollar trade balance as a result of purchases, which would ordinarily have been stretched out over a period of years. Normally they would have purchased what they needed, and the balance of trade kept practically level, although it was turning in our favor, but instead of taking a sufficient amount of time so that demand would balance demand, or so that we would absorb direct securities from the other side, as England and France did in the past, this balance piled up through an immense one-sided purchasing on the part of foreign buyers in a short time.

Such a thing would not have happened, if this balance of trade had gradually grown in our favor rather than to be dumped upon us. We would have had a gradual balance of trade to even up, and as it was gradual, we would have absorbed securities as the natural way to balance up that trade. It was not possible to educate the people of this country as to the advantage of absorbing foreign securities direct, since they had been a debtor people so long that they do not know what to do as a creditor.

Therefore, there had to be a medium through which to absorb these securities, first investigating their worth, and then pooling them and issuing debentures based on them to the people. It has been felt that the big jump in the balance of trade with its consequent disruption of exchange would, undoubtedly, not have come if securities had been absorbed to correct it. Therefore, let us consider a proposition which will absorb these securities in sufficient volume to have some effect on the balance of trade. This is the reason for the immense size of the Foreign Trade Financing Corporation.

Let us see whether we want securities or not. In the first place, if we do not get securities in payment for the goods we have sent abroad, we are going to get other goods. Do we want a tremendous amount of imported goods dumped in on us? We want raw materials that we do not produce. We want many things, such as coffee, rubber, sugar, etc., cheaper, so that we will get more of the good things of the world that we do not produce for less of our individual effort. We want imports of certain goods, but we do not want four billion dollars' worth of manufactured goods dumped into the country, when we are now able to produce more of manufactured goods than we can consume. Wouldn't it be better to absorb good securities and have foreign people pay us interest? In the last analysis, we must import goods, gold or securities to settle our trade balance. We do not want the goods—we have taken all the gold foreign people can spare—and now we stand up against a wall because we cannot absorb securities. For the present we have taken more than enough from Europe that is movable. We do not want any more. We must become, as we would have become under normal conditions, a rich investing nation, as every rich exporting nation in the past has always become.

The question then is, whether this country will back up its export trade. It is not a question of whether the Foreign Trade Financing Corporation itself will succeed or not. The question is, whether we can get behind the proposition and by group thinking and concerted action, solve one of the biggest problems that has ever confronted our country. Put it another way, the question is, whether we have to depend upon a crisis to show the country that it ought to have done what the brains of the country are now telling us we ought to know.

---

* From an address delivered at Editorial Conference luncheon, Associated Business Papers, Inc., New York, February 18, 1921.

** President, Royal Typewriter Company, and member, Organization Committee, Foreign Trade Financing Corporation.

The problem is one which it will take an immense institution to handle. We will say now that we want to solve one particular problem, and I will lay it in front of you concretely.

There is in Australia to-day a market for American automobiles. We are not shipping them. Why? Because there is not a dollar market in Australia at this moment, and for that reason many of our men in Detroit are not working, and we are not producing the automobiles. We must create a dollar market in Australia in order to sell our goods there and keep our men working. How are we going to do it? By long-term credits. Is it right that we should have unemployed workmen in the country when we can by right action revive our market abroad? This is not being done out of charity of our hearts to help people who cannot help themselves. It is not an effort to make the League of Nations work. It is to develop the market for American products outside the United States. Why not take our dollars—put them to work—go on paying our workmen and keep up the prosperity of the country?

We manufacture a tremendous amount of goods in America beyond the amount that is needed for home consumption. Naturally we cannot sell them in America. We need outside markets to dispose of them. When we cannot do this, there is unemployment for the men who manufactured these goods. When all is said and done when we export, we export labor. Labor is the biggest part of all goods we export. Take the automobile. The manufacturer of this article does not make ten percent profit on his turnover. If he did, he would be many times a millionaire. No, he makes nearer 5 percent. Fifteen percent of his cost goes to buying raw materials. The remainder goes into labor. In the end, more than 75 percent of his cost goes to the workman. What, therefore, we are trying to do is to take the time sheets out of the factories of America, export them, and bring back payrolls for our American workmen.

When you finance foreign trade, you only finance the time of our American workmen a bit further to its ultimate consumer.

Let us take the automobile again. Suppose that you grant three months' credit. Where will that three months take the automobile? Make it simple. Probably to the top of the Andes Mountains, or half-way across the Pacific Ocean. In three months the automobile has not reached the ultimate consumer. You haven't got it far enough toward the payroll for your workmen's time sheets.

Some time ago, we, as manufacturers, sat back and said to the parties in the other countries, "Come to our factory and get the automobiles, and pay us cash." The farmer said, "Come and get my corn from the farm or the local elevator, and pay cash." When our exports began to decline, our producers relented a bit, and financed their goods to the port of shipment, letting the buyer take and pay for them there. Now our exports have shrunken so far, and our available financial machinery has become clogged so much, that we cannot carry the goods any further along to the ultimate consumer. It is impossible for the foreign buyer to take goods on the terms made available by our commercial banks, and therefore we cannot sell the goods.

The explanation is very simple. We haven't the machinery to carry our work to its ultimate consumer. We used to say to the buyers, "You come and take our goods and use your own money to finance them." Now that we can no longer do this, we must either stop selling or find some way to carry our goods further along to the people who use them and consume them.

This is not the bankers' problem alone. It is the people's problem. It requires *group* thinking, *group* action.

Look at the people of Great Britain. They eat, sleep, work and live in export trade. There are forty million people thinking of export trade. Look at what they have done in export trade. Then wouldn't we rather have forty million people solidly back of the proposition to finance our exports than a hundred million people uninterested and unconcerned? This same thing is true of France and Germany.

I think that having a hundred million people, all wearing the same hats, the same clothes, the same ties, the same shoes, all eating the same things, is a tremendous advantage for any nation. It gives a standardized market for the products of the country. That gives us a great advantage in going out and selling these standardized goods in the world's markets. But this great body of one hundred million people is unorganized, and you know that an unorganized majority in many cases will not do what an organized minority could.

The answer is this: We must educate the people. We must bring about group thinking, making the people realize that what we are doing is putting machinery in operation, which will back their payroll. We must make them understand that it is their problem. If all of us sit aside and wait for somebody else to act, the task will never be done.

I am thoroughly convinced that what we need in this country is to think together, work together, act together, in a real spirit, and then the financing of our foreign trade will go over and be one of the greatest propositions of the world.

Hydraulic System for Stowing and Handling Fuel Oil on Board Ships or in Yards or Docks

THE sketch accompanying this description shows the adaptation of a hydraulic system for the control of the fuel oil of a large dredge. The solid lines show the run of oil piping from the tops of the various tanks to the oil control manifolds. The dotted lines show the run of the water piping from the bottoms of the corresponding tanks to the water control manifolds.

In this drawing the manifolds are located so as to avoid crowding the space on the floor of the boiler room and to relieve the pressure on the tank tops. A filling main from either side enables oil to be delivered directly to any selected tank.

The water control manifolds are connected to a convenient source of water supply, but preferably to the condenser discharge as well as to a main from a water pump.

Double Connection of Water Control

The purpose of the double connection is that in ordinary feed to the burners the water from the condenser discharge is in more than sufficient quantity to keep the booster pumps flooded, while the water pump is used directly for the purpose of transfer of oil from any tank or tanks to any other tank or tanks or overboard.

The water pump is equipped with a special double ported transfer valve so designed that the operation of a single lever enables the operator to discharge water from the tank from which oil has just been transferred overboard without further action than to pull the lever of the valve. It is not necessary to stop the pump nor to operate other valves.

The run of the piping on these diagrams is shown as direct as possible, but it is immaterial that these runs should be exactly as shown if necessity requires some detour around obstructions. The pipe line sizes are of customary dimensions for the oil piping, while the water piping is generally smaller.

Advantages of System

It is in the detail of connections of piping and in the calculation of various heads and in the enlargements at certain necessary points that the functioning of the system is effected. It has been found that the run of the piping is in many cases appreciably less than with the old suction system.

When the ship's fuel is handled by this system it is possible

to dispense with transfer pumps, vent pipes, high and low suction, expansion trunks and special settling tanks. This means that the initial economy is noteworthy. With this system of stowage of oil certain phases of expense are moderately reduced and there is an appreciable saving, especially with the lighter oils in the volatilization of the lighter components. Operation by this system is safe, more convenient and cleaner.

Two essential facts in connection with this system are: First, the fuel stowage tanks are kept completely filled with liquid; second, clean oil is fed from the top of the tank.

Some of the features under the first fact are:

(a) By keeping the tanks always full of liquid, no air can come in contact with the fuel in stowage and therefore no gases can form. This automatically eliminates all dangers from fires and explosions arising from such gases.

(b) It prevents the deterioration of oil because no gases are allowed to form.

(c) The tanks being full, there is no free surface of fluid. Surging, with its dangers, is prevented. The strain and stress on bulkheads are eliminated and also the rupture of the joints and connections.

(d) The metacentric height of the vessel may be more accurately determined and better stability conditions obtained, as no allowance is necessary for partially filled tanks.

Some of the features under the second fact are:

(a) Only clean oil can be delivered to the supply tank pumps, burners, carbureters, bearings or other destinations for use.

(b) The elimination of foreign matter from the oil prevents the clogging of valves, burners or carbureters and the cutting of the pump cylinders and pistons.

Any oil that is in condition to flow is very readily handled by this system. This means that where heating is necessary in the suction methods it is also necessary with the hydraulic method.

The transfer of oils from docks to boats or vice versa is accomplished without discharging dangerous and obnoxious gases into the atmosphere in the vicinity of the vessel.

The trim of the vessel can be effected by the hydraulic system, the more readily the lighter the oil in question. The draft of the vessel and also the trim can be maintained practically constant as required. On the other hand, any tank may readily be emptied to lighten the vessel, and the tank so lightened can be made safe with much less steaming than under present practice. Valves or other safeguards deemed advisable, which are not in direct opposition to the principles actuating this system, can be used as desired.

This system has been investigated and approved by the United States Steamboat Inspection Service, the American Bureau of Shipping, Lloyd's Register of Shipping and the British Board of Trade. The system is especially applicable to the installations of oil burning galleys where trouble frequently arises under present methods.

Description of Operation

A description of the operation movements required with this system shows that it is not necessary to go from one end of the ship to the other to manipulate valves and that the frequent accidents due to this are avoided.

Filling

Pull the levers of the oil control valves of the tanks to be filled. It is not necessary to touch the water control valves; they are in such a position that water is discharged in equal amount with the oil taken aboard.

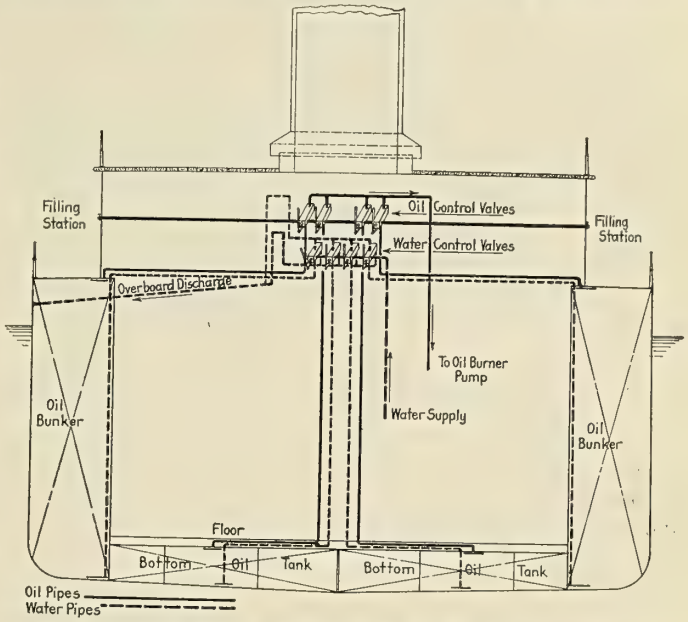
Transfer

To transfer fuel from a bottom tank to a high tank, for example, open the respective oil control valves by pulling their levers and pull the lever of the water control valve of the tank from which the transfer is made. If there is haste to complete the transfer, the water pump should be put in service, otherwise transfer will slowly take place from water drawn from the condenser discharge.

Oil to Burner

As the oil is always on the burner line, nothing more is necessary for delivery than to regulate the valves of that line as usual.

It is possible to arrange that the tanks' contents may be known at any time by consultation of specially designed pneumercator gages and alarm may be given as the tank approaches the condition of full or empty. The matter of alarm may be covered by one of two methods. One is by the use of



A Simple Transfer System, Showing Oil on the Burner Line from the Port Wing Tank—Water Control Valve, Only, in Use

For transfer from starboard to port wing tank, pull oil control levers for these tanks and also water control valve for starboard wing tank. If there are more tanks than shown, it is necessary to add one valve for each to the water and oil control manifolds, respectively.

an electric relay, which is entirely safe and simple, and the other is by an attachment to the gages.

A feature of this system is the fact that it is subject to instant control in emergency. The tanks, being full, are safe in any case, but in emergency the pushing of an electric button prevents the feeding of oil in the entire system or in any distinct part of it. In the event of the piping being carried away, oil from the tanks cannot be discharged within the ship.

In other applications of the systems for stowage on shore for the service of vessels the advantages are equally definite. Where conditions permit, it is possible at the extreme range of the adaptation to provide an entire system regardless of the size without valve of any sort other than the valve on the end of the delivery line. In ships, tenders, yachts, scows and other craft similar systems are readily designed.

It may be noted that the principles involved have been successfully used for land installations for some fifteen years and are standard with many companies from one end of the country to the other.

Classification of Export Coal.—A co-operative agreement has been effected between the Tidewater Coal Exchange, Inc., of New York, and the United States Bureau of Mines for the classification of coal shipped for export through the ports of New York, Philadelphia and Baltimore on a basis of accurate sampling and analyses. The agreement provides for the establishment of limits and tolerances of quality for certain pools and for the maintenance of the quality of the pools within the limits specified. The agreement applies to coals shipped from Pennsylvania, Maryland and northern West Virginia. In 18 months 48,000,000 tons of coal, in approximately 1,000,000 cars, were shipped from these districts through the Exchange.

Rules and Regulations for Freeboard*

Review of Regulations in Foreign Countries Governing Freeboard —Discussion of Requirements for Ordinary Sea-Going Cargo Vessels

BY DAVID ARNOTT

THE freeboard of a vessel is usually defined as the height of the side above the load waterline at the middle of her length measured from the top of the deck at side and marks the limit of loading which is considered consistent with the maintenance of a proper factor of safety under all conditions of wind and weather. Freeboard rules and regulations are an endeavor to define this limit, and one can readily understand that the problem of fixing a safe load line for a complicated floating structure moving through and supported in a constantly varying degree along its length by a fluid which is itself in motion does not lend itself to simple mathematical treatment.

There are, however, obvious and essential considerations which must be kept in view in determining the proper freeboard for any vessel:

(*a*) The provision of that height of platform which will prevent any undue tendency to ship water aboard with consequent deck damage and which will insure the crew getting about the deck in heavy weather with, if not comfort, at least comparative safety.

(*b*) A reserve of displacement, i. e., reserve or spare buoyancy, must be provided as a margin against possible leakage and entry of water into the holds.

The freeboard as determined from the above considerations has been termed the geometric freeboard and is the minimum freeboard allowable having regard to the vessel's dimensions, form and type.

(*c*) The vessel must have a sufficiency of structural strength to render her safe when loaded to the minimum or geometric freeboard.

As a ship, like any other structure, must be designed for the load to be carried, freeboard and strength cannot be disassociated and the inclusion of a definite standard of strength in any freeboard regulations is essential.

(*d*) If the vessel has a deficiency of structural strength as compared with that of the freeboard standard, the freeboard must be increased in order that the reduced load carried will render her relatively as safe as the standard vessel.

Although the present load line bill before Congress appears to be the first serious attempt to provide load line legislation for this country, the desirability of placing some limit on loading seems to have been recognized for many years prior to 1917, at which time the United States Shipping Board took definite action and issued instructions that load lines be marked on all vessels building and to be built for the Emergency Fleet Corporation. Marine underwriters, as one would expect, had always endeavored to see that the loading of vessels in which they were particularly interested was kept within reasonable limits and their surveyors had instructions to report cases where, in their opinion, vessels were overloaded to an undesirable extent. The American Bureau of Shipping's "old rules" emphasized the importance of adhering to general principles by which the amount of freeboard for safety might be determined and contained a general table of freeboard allowances which varied from 1½ inches per foot of depth of hold at 8 feet to 3¾ inches per foot at a registered depth of 30 feet for full scantling vessels, with one-half of this allowance for hurricane deck vessels. In the case of vessels of the latter type in which the deck below the superstructure, or hurricane deck, was the main strength deck, the minimum freeboard proposed required to be submitted to the committee before classification was granted.

Mr. Lewis Nixon, in a paper before the Society of Naval Architects and Marine Engineers in 1897, while criticising certain minor features of the British freeboard tables in force at that time, gave expression to his own personal opinion regarding a compulsory load line in these words: "It must not be assumed that the general opinion of having a definite safe freeboard for vessels is wrong, for as it stands this is a very wise law, and if it is administered impartially and without undue interference with trade it is of the utmost value to floating property." In the discussion following the reading of his paper it transpired that a bill to regulate freeboards,

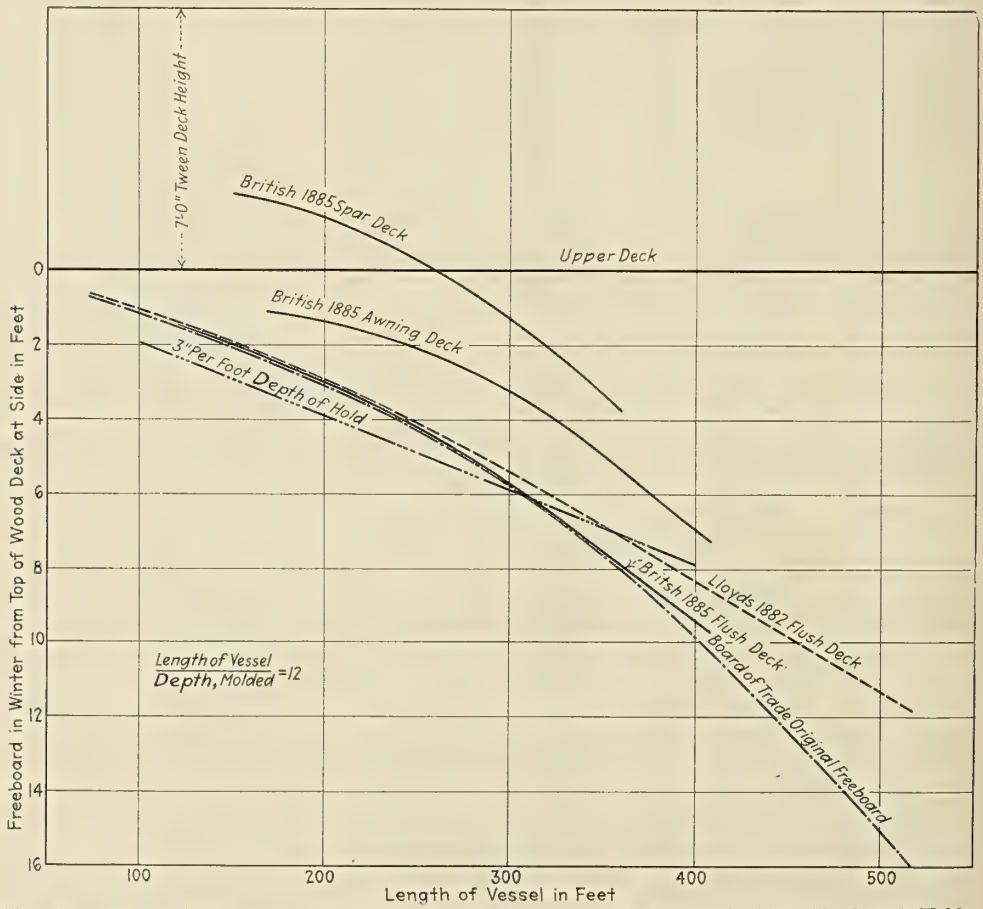


Fig. 1.—(Steamers) Comparison of Early British Freebroads With British 1885 Freeboard Tables

* Paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1920.

particularly for lake vessels, had been introduced into Congress some years before but was dropped when it was pointed out that most of the channels of the Great Lakes would not allow of vessels being loaded to their proper freeboard. The opinion was also expressed that freeboard was not so vital a question in the United States as in some other countries, owing to the limited draft of harbors and the extensive use in the coasting trade of hurricane deck vessels with sides high out of water.

It is interesting to note that as long ago as the year 1874 the enterprising builders and shipowners of the Great Lakes district met in council at Buffalo and not only came to the conclusion that the marking of a load line on both ocean-going and lake vessels was desirable, but after mature deliberation formulated rules for freeboard and drew up a set of construction rules for wooden vessels in which a laudable endeavor was made to assess the dimensions of the various timbers entering into the structure with some regard to the strength required instead of tabulating scantlings on the basis of the vessel's tonnage as was the practice of the time, the molding of the floor timbers, for example, being fixed by the length of the floors and the load draft. The freeboard rules recommended by the Buffalo convention were intended to apply only to vessels of the highest class in existence at that time.

The first legislation in Great Britain dealing with the loading of vessels was the Merchant Shipping Act of 1871, which contained the provision that seagoing vessels must have draft marks at the stem and stern and required that the load draft of a vessel should be recorded before leaving port. The law was useful in that after this date reliable evidence with regard to load draft was available when investigating the losses of ships at sea. Although a royal commission, appointed as a result of the popular agitation led by Samuel Plimsoll, reported that the enforcement of any standard freeboard regulations would be disadvantageous, if not impossible, the continued interest of the public forced the passing of the Merchant Shipping Act of 1873, which provided for the detention by the Board of Trade of overloaded and improperly laden vessels. The Merchant Shipping Act of 1875 required owners of foreign going vessels to mark a circular disk on the sides at the maximum draft, to record the amount of this freeboard before clearing at the custom house and to insert this record in the agreement with the crew; the Act of 1876 made these requirements compulsory for all British vessels except coasting vessels under 80 gross tons, fishing boats and yachts.

It should be noted here that, although an owner was compelled by the foregoing legislation to mark load lines on his vessels, the position of the load line as indicated by the disk was entirely a matter of personal opinion and could be altered from voyage to voyage. The officers of the Board of Trade had power to detain a ship which was overloaded, but as there were no legally recognized freeboard rules from which to determine the limit of loading, one can readily imagine the endless disputes which arose between owners and officials as to what constituted an overloaded ship within the meaning of the act.

A conference which was called in 1875 to ascertain the practicability of laying down rules for guidance of the Board of Trade surveyors was abortive as far as the direct object of the meeting was concerned, although agreement was reached on certain fundamental principles which it was considered should govern the determination of freeboards. Upon the introduction of spar and awning deck vessels Lloyd's Register of Shipping made the marking of an approved load line on these special types a condition of classification and in 1882 published freeboard tables capable of general application which were based on reserve buoyancy percentages. At about the same time the Board of Trade issued freeboard rules for the guidance of the surveyors, and as there was also in use a scale of freeboard allowances recommended by the Liverpool Underwriters' Registry, the necessity of endeavoring to arrive at a uniform basis for determining freeboards was urgent.

The first load line committee was appointed by the Board of Trade in 1883, and after extensive investigation reported in 1885 "that it is now practicable to frame general rules covering freeboard which will prevent dangerous overloading without unduly interfering with trade."

All obtainable evidence as to what constituted a safe loading for vessels was collected from owners and masters and the freeboard tables recommended by the committee embodied the results of ripe

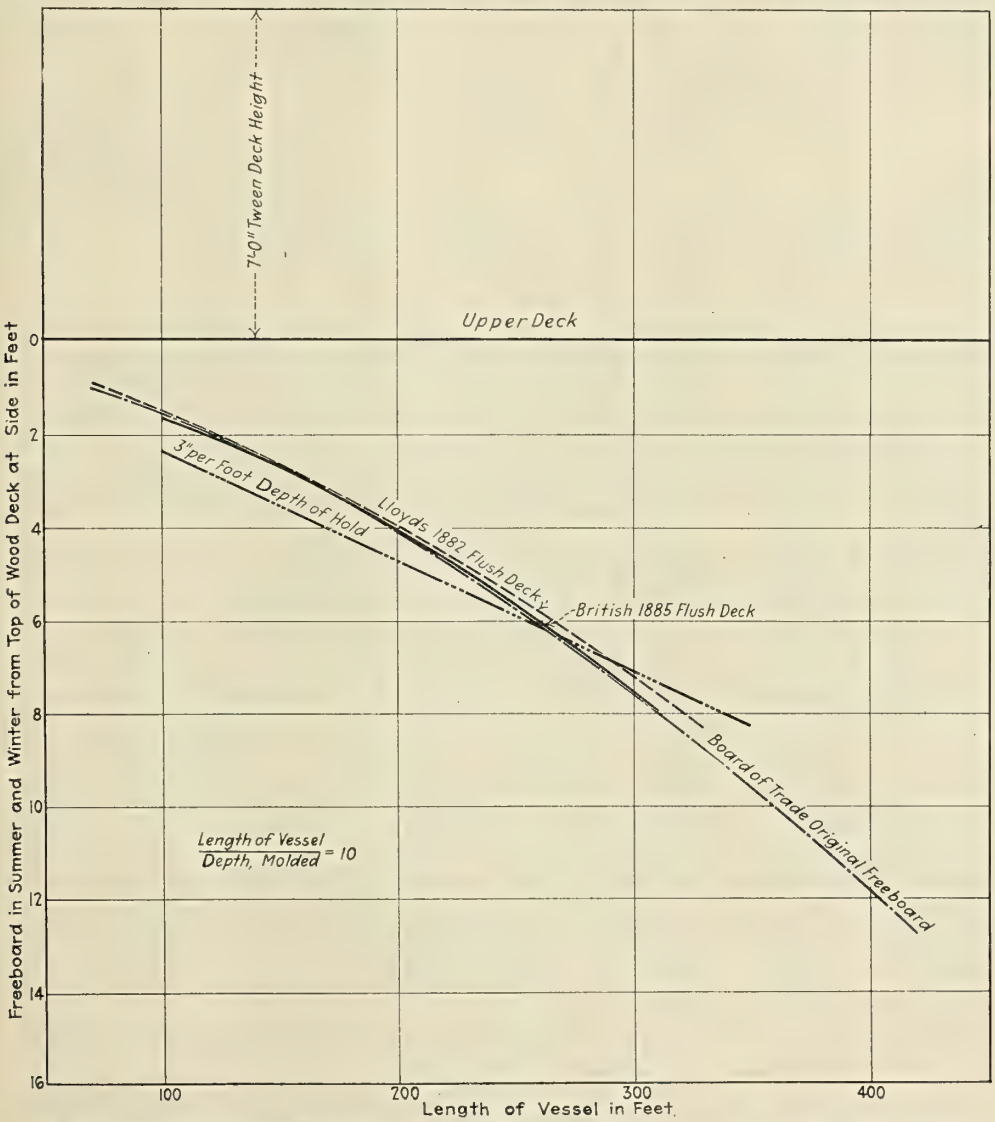


Fig. 2.—(Sailers) Comparison of Early British Freeboards With British 1885 Freeboard Tables

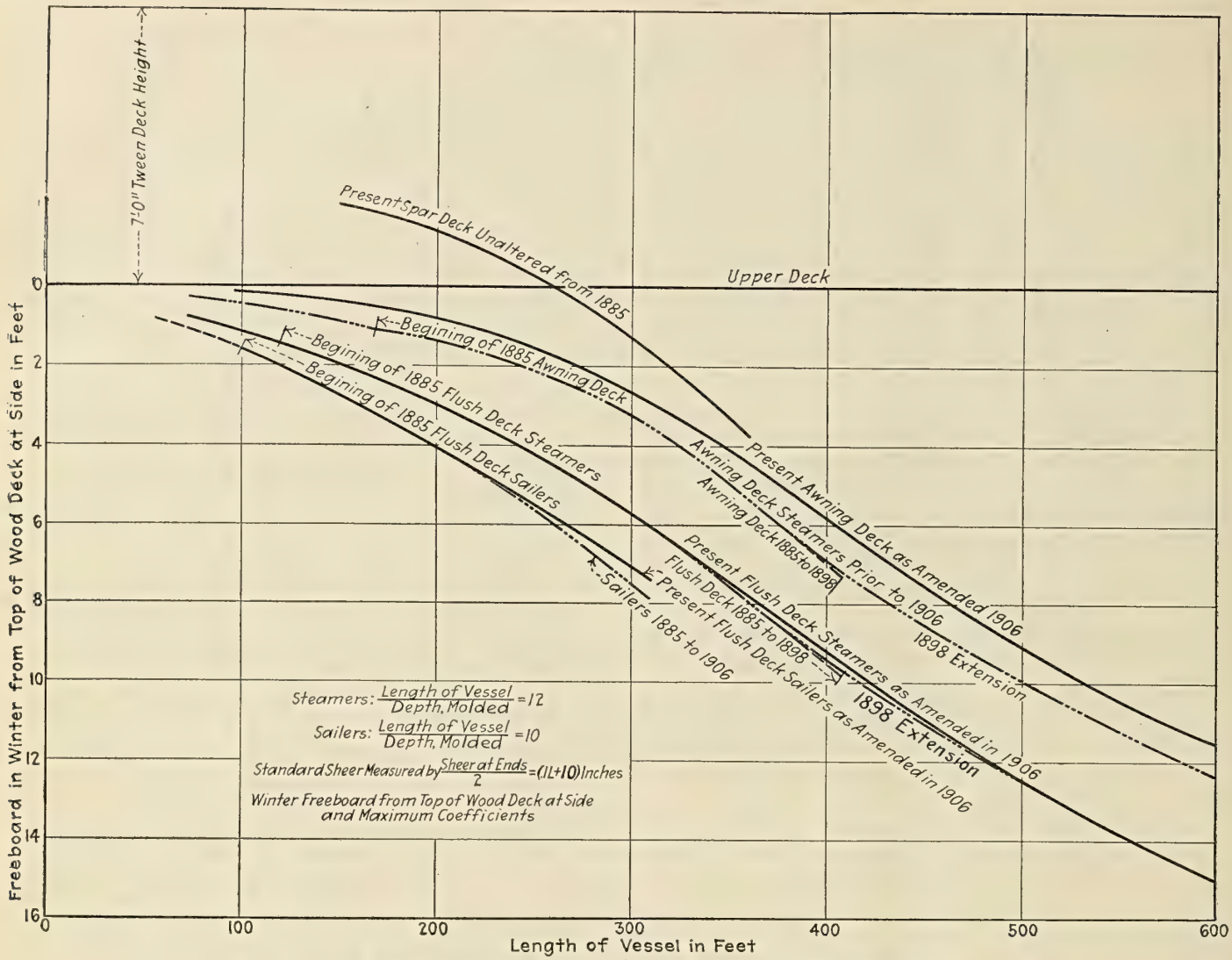


Fig. 3.—Showing Alterations Made to British Freeboard Tables Since 1885

practical experience within the limits of the dimensions of vessels existing at a time when a cargo vessel of 300 feet in length was considered a big boat. These rules, which were based on Lloyd's 1882 tables, were approved by the Board of Trade, and a large number of shipowners, to their credit be it said, voluntarily took steps to have freeboards marked on their vessels in accordance with the new regulations, although not legally required to do so, since it was not until 1890 that the Merchant Shipping Act of that year provided for the compulsory marking of all, except some of the smaller class of British vessels, with freeboards as recommended by the 1885 load line committee. Lloyd's Register and the British Corporation were empowered by the Board of Trade to assign freeboards and the act itself contained a clause to the effect that due regard should be paid to the views of the assigning bodies in administering the regulations and in the making of any modifications in the freeboard tables which might be found necessary. This undoubtedly has had much to do with the fact that load line administration in Great Britain has never been oppressive and that the freeboard rules and regulations have been modified from time to time in order to keep pace with the development of shipbuilding and the evolution of new types of vessels.

The Merchant Shipping Acts of 1894 and 1906 extended the provisions of the previous acts, the 1906 Act cancelling the exemption previously granted to coasting steamers under 80 tons gross and requiring all foreign vessels in British ports to have load lines marked in accordance with the British or other freeboard regulations considered equally effective.

It may be worthy of mention here that under the regulations made by the Board of Trade, by virtue of the authority granted under the Merchant Shipping Act, a vessel must be maintained in good condition to continue to hold a freeboard certificate. Freeboard certificates, in the case of classed vessels, remain in force as long as the original class is maintained, except in the event of structural alterations being carried out to deck erections, etc., which may have affected the freeboard assigned. In the case of unclassed vessels freeboard certificates are issued for a period not exceeding four years, depending on the age and condition of the vessel. In the event of a vessel's class being cancelled or alterations made to the hull structure which affect the freeboard and where the time for which a certificate was granted has expired, the freeboard certificate must be handed in for cancellation and application made for a new certificate, otherwise the Board of Trade officers may notify the collector of customs who has power to refuse clearance of a vessel on this account. A freeboard certificate is issued only after the markings have been verified and permanently cut in on a vessel's sides. The particulars on the certificate must be entered in the official log and the freeboard certificate framed and kept aboard the ship.

The 1885 load line committee's freeboard tables, which in 1890 became the legal regulations, were based on Lloyd's 1882 tables modified to agree with the views of the Board of Trade with regard to the value of erections, provision for the height of platform in the larger vessels and the differences in freeboard for season of the year and trade, i. e., summer, winter and winter North Atlantic. The table freeboards for flush deck steamers and sailers were based on reserve buoyancy, varying from 22 percent in the case of a steamer 120

feet in length and of standard proportions to 35 percent for a steamer 408 feet long, the effect of the length corrections and coefficients of fineness given in the tables being to give the same percentage of reserve buoyancy to vessels of the same length. The awning and spar deck table freeboards were determined on a basis of the strength of the Lloyd's rule awning and spar deck vessels of that date. Figs. 1 and 2 show the 1885 table freeboards for steamers and sailers in comparison with the original Lloyd's 1882 and Board of Trade freeboards, these early British freeboards having been reproduced from a similar diagram in Foster King's paper read before the Institution of Naval Architects in 1906, entitled "Notes on Freeboard."

The standard of strength laid down for use with the tables was Lloyd's 1885 rules, in which definite scantlings were tabulated for full scantling spar deck and awning deck vessels on a basis of numerals. Owing to the improvement in distribution of materials which came into vogue about the time the first British Corporation rules were issued in 1893, so-called spar deck vessels were being built relatively as strong as the 1885 three deck vessel and were assigned minimum freeboards on the basis of a strength comparison. A similar situation exists today in the modern "shelter deck with freeboard" vessel, in which the scantlings are somewhat less than full scantling classification requirements, and the granting of the minimum freeboard to this type can be justified only because of the lower standard of strength allowed by the freeboard regulations.

The German freeboard tables were, in effect, the British tables improved and modified to suit the changes which had taken place in types and construction of vessels since 1885. The German rules contained tables of freeboards for both full scantling steamers and sailers, also for awning deck vessels, but no separate table was given for spar deck vessels. The depth used with the tables was measured to the top of the deck, whether of wood or steel, and the table freeboards were given from the top of the deck to the center of the disk, i. e., summer freeboards instead of winter freeboards as in the British regulations. As considerable improvement had taken place in the distribution of material, with a corresponding increase in the strength of vessels with complete superstructures, the reduction in freeboards granted by the German tables to vessels of the awning deck type was justified on that account. The new German sheer standard, which was considerably above that of the British tables, was also more in line with modern practice. Fig. 4 shows the comparative sheers in the case of a 400-foot vessel.

While in the British tables no correction is made for excess or deficiency of sheer in the case of awning or spar deck vessels, awning deck vessels in the German tables received an allowance for excess of sheer over the standard and were penalized for deficiency of sheer in the same way as for flush deck vessels. Detailed instructions were given for the method to be adopted in assigning freeboards on the basis of strength, the standard of strength adopted for use with the tables being the 1903 Germanischer Lloyd's rules. Vessels carrying wood

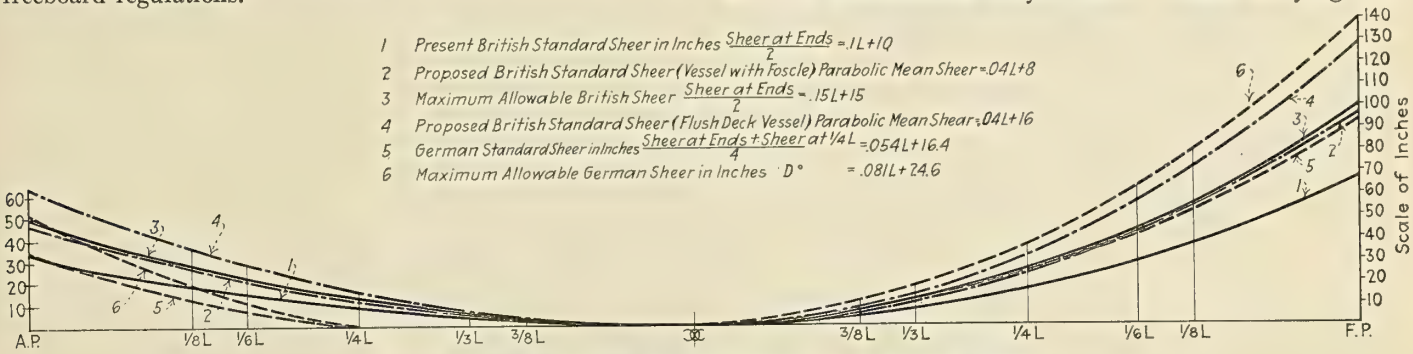


Fig. 4.—Diagram Showing Standard Sheers for a 400-Foot Vessel

Except that explanatory notes were added in later editions in order to insure a uniform method of calculating freeboards on the part of the assigning bodies, no major changes were made until 1898, when the tables were extended to include vessels of 50 feet molded depth, as shown in Fig. 3. Methods of determining the freeboards of special types, such as turret deck and shelter deck vessels, were added to the regulations at this time and modifications were also made in the freeboards of vessels engaged in the winter North Atlantic trade.

As the publication in 1903 by the German Marine Association of freeboard rules which differed appreciably from the British regulations strengthened the hands of those who had been urging a further revision of the British tables, it may be desirable at this stage to draw attention to the departures made from existing British practice. Before the advent of load line legislation in Germany a large number of German vessels had freeboards assigned by one or the other of the British assigning bodies, but in 1900 the German Marine Association, having decided that some control over the loading of vessels was desirable, issued instructions to owners to report the draft of their seagoing vessels on each voyage, together with the amount, nature and stowage of cargo carried. The results of this investigation were submitted to the Germanischer Lloyd's and in 1903 the freeboard rules proposed by that classification society, as amended in conference with representatives of the shipping and shipbuilding interests, were finally adopted and received the approval of the German government in 1904.

in holds and having deck cargoes were allowed less freeboards than given by the tables provided they had sufficient stability, but no method of estimating this deduction was given. Small coasting sailers under 100 tons gross were allowed to load in summer deeper than given by the tables by a maximum allowance not exceeding the reduction allowed for loading in fresh water, and no addition was made to the freeboards either for steamers or sailers engaged in the North Atlantic trade in winter.

Owing to the reduction in freeboard granted to awning deck vessels it was found that the new German regulations gave reductions in the freeboards of vessels with long erections, as compared with the British, which were so considerable that it was evident that modifications would be necessary either to the British or German tables, or both, before the governments concerned could accept each other's regulations as being mutually effective.

In order to meet the situation which had arisen owing to the introduction of the German freeboard rules, the British Board of Trade called a conference of the assigning bodies, with the result that drastic alterations were made to the British tables, which had the effect of allowing considerable reductions in the freeboards of the majority of vessels, it being estimated that the reductions in freeboards granted represented an increased carrying capacity for British shipping of 1,000,000 tons. The freeboard tables, with the exception of the spar deck table, were modified and the amendments are shown in Fig. 3, which indicates clearly the considerable re-

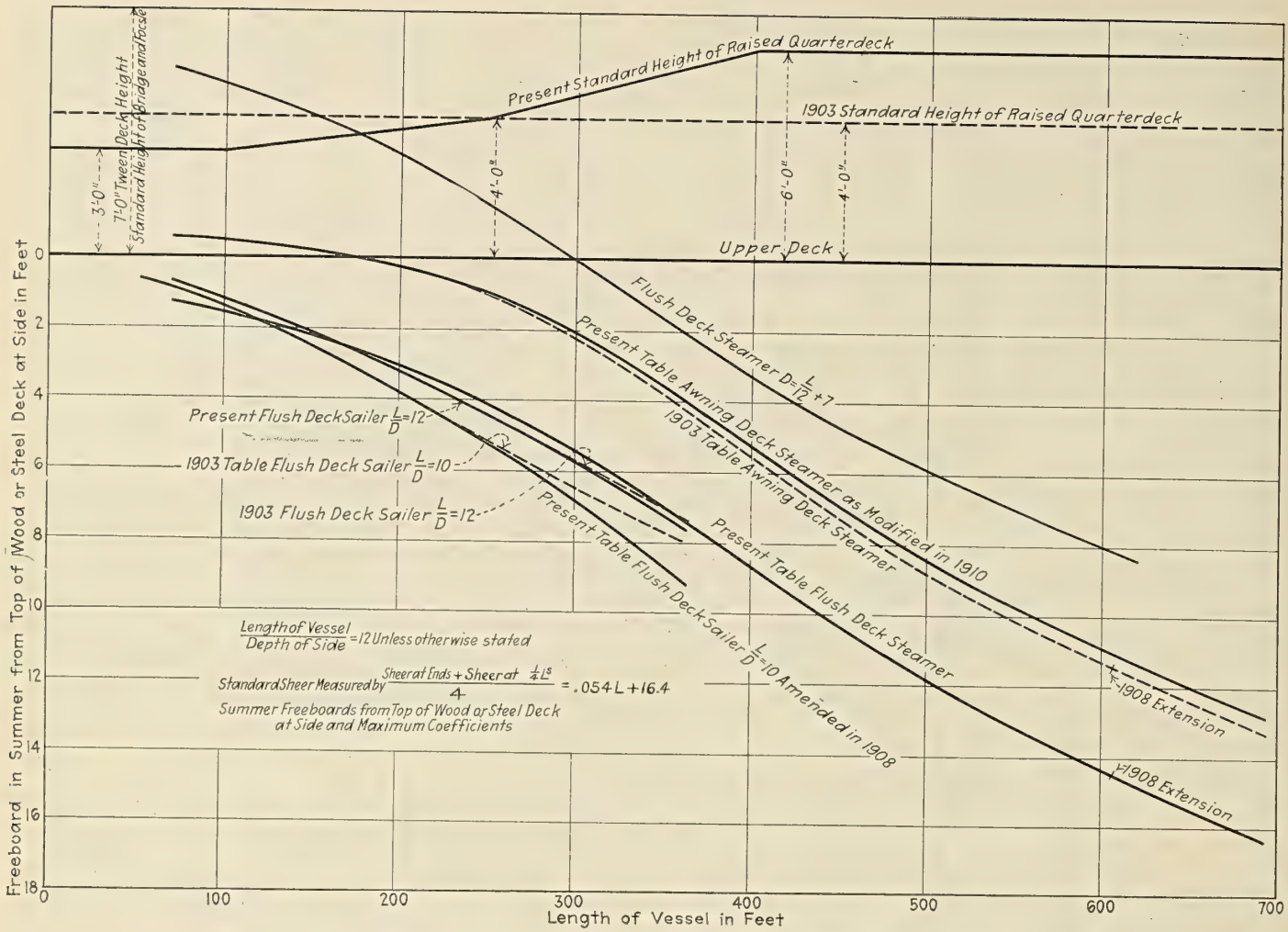


Fig. 5.—Showing Alterations Made to German Freeboard Tables Since 1903

ductions made in the freeboards of awning deck vessels, the fairing up of the flush deck freeboard curve from 28 feet to 42 feet molded, and the reductions made to the freeboards of the larger sized sailing ships.

The increased drafts allowed by the new awning deck table necessitated a higher standard of strength for this type, and the old standard, i. e., Lloyd's 1885 awning deck rules, was augmented by the addition of heavier topside scantlings. In addition to the table alterations the allowances for erections were modified, consideration was given to the freeboard of vessels with scuppers and other openings in the side and it was decided that the maximum reductions under the revised regulations should be granted only where the means of closing all such openings were satisfactory, the machinery casings above the upper deck were of sufficient height and strength, and the hatchways, hatch covers, etc., were efficient and in good condition. When these conditions were not complied with, the freeboards were to be increased, due regard being given to the vessel's trade.

In 1908, with a view to bringing German freeboard tables into line with the revised British requirements, modifications were made to the erection allowances and more detailed information was given for dealing with the freeboards of special types such as shelter deck vessels with tonnage openings. The provisions contained in the British 1906 rules with regard to the protection of openings, nature of appliances required for closing openings in erection bulkheads, height and strength of machinery casings and cargo hatches, and the requirements as to ports, scuppers, etc., were all included in the 1908 German rules. The British practice of adding to the freeboards of vessels engaged in the winter North Atlantic trade was adopted and the special consideration previously given to wood cargo vessels and small coasting sailers was cancelled. The flush deck and awning deck tables were both extended and increases were made to the table freeboards in the case of the larger sized sailers. In 1910 the German awning deck table was modified as shown in Fig. 5.

The latest British load line committee was appointed in 1913 to advise the Board of Trade on the attitude to be adopted by the British representatives at a forthcoming international conference on load lines and also to investigate and report as to whether the 1906 revised tables required further revision in the light of experience. Owing to the outbreak of the war, however, this conference was never called and for the same reason the issue of the committee's report was delayed until the end of 1915. The decisions given by courts of inquiry into the loss in 1912 of two vessels whose freeboards had been reduced in 1906 caused considerable comment and probably had something to do with the terms of reference. In one case the court had found that the primary cause of the loss of the ship and lives was her insufficient freeboard, and in the other, while the loss of the ship was not attributed to lack of freeboard, the opinion was expressed that the freeboard granted under the revised regulations was dangerously small. It is not the purpose of this paper to go into detail with regard to the findings of the committee, as copies of the report (published in 1916) are easily obtainable, but anyone who has studied it will agree that the report is outstanding in respect to the importance of the recommendations made and somewhat unique from the fact that underlying reasons on which the recommendations were based are stated in detail.

In investigating the effect of the 1916 revision of the freeboard tables every consideration was given to the record of

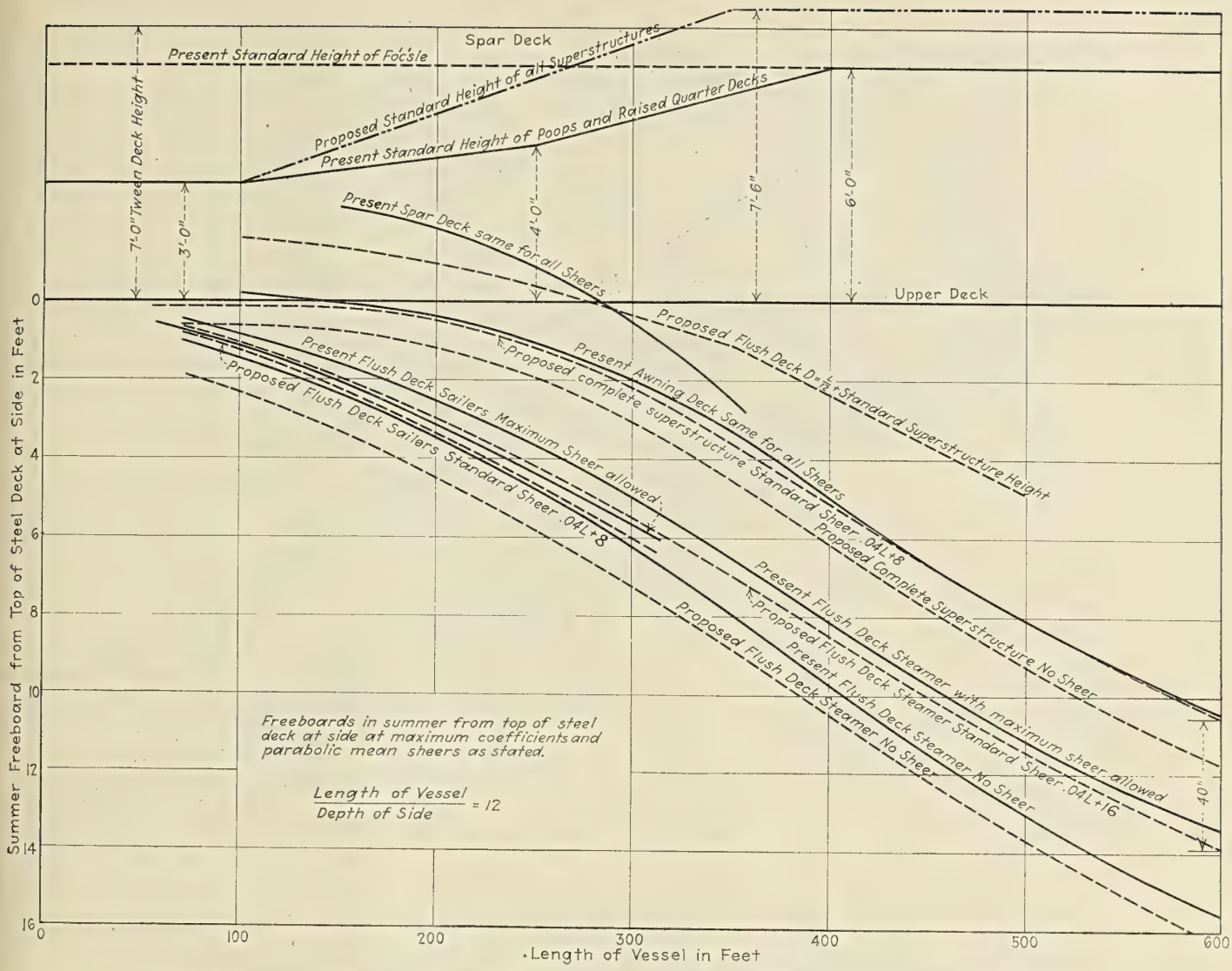


Fig. 6.—Comparison of British Load Line Committee's Proposed Freeboards With Present British Freeboards

shipping casualties and to the experience of shipowners and masters as to the behavior of their vessels since they were marked with the new load lines, the classification societies being also consulted as to the practical working of the revised freeboards over a period of seven years and their effect upon the number and nature of actual damages sustained to classed vessels. The load line committee, after reviewing the evidence in the two courts of inquiry mentioned above, decided that insufficient freeboard had nothing to do with the loss of either vessel and came to the conclusion that there was no foundation in fact for the allegation that the 1906 revision of the freeboard tables had caused a considerable increase in the number of losses of vessels. The opinion was expressed, however, that although the freeboards allowed by the revised tables were quite sufficient to insure the safety of vessels, the reduction in freeboard in some cases had had the effect of making the ships less comfortable owing to the greater liability for water to come on board the weather decks.

The subcommittee which was appointed to deal with the highly technical questions involved in freeboard, having decided that the present British regulations were not adapted for an international standard, proceeded with their investigations with a view to evolving new freeboard rules and regulations suitable for submission to an international conference. The existing British rules, owing to the many additions, modifications and amendments made since the first issue in 1885, had become complicated and somewhat difficult to apply and did not treat the different types of vessels in an equitable manner. Every endeavor was made in drawing up the new freeboard regulations to make the rules simple and easy of application, and the result of the committee's labors is embodied in their proposed rules for the assignment of load lines to merchant vessels which are undoubtedly a considerable improvement over the present regulations.

Fig. 6 shows the proposed new table freeboards in comparison with the present British tables, and Fig. 7 a comparison with the present German tables. There are now two distinct sheer standards, parabolic curves where the sheer forward is twice the sheer aft, one for vessels with forecastles and a higher standard for flush deck vessels (Fig. 4). Although all types of vessels are penalized for deficiency of sheer as compared with the standard, it is not proposed to grant any allowance for excess of sheer over the standard. Block coefficients at 85 percent of the molded depth are used with the tables instead of coefficients of fineness derived from under deck tonnage. The depth to be used with the tables is taken to the top of the deck at side, whether of wood or steel, and summer freeboards are tabulated as in the German regulations. The committee recommend that the freeboards of British ships be marked from the deck at side instead of being set down from a statutory deck line in accordance with the Merchant Shipping Acts. A more logical method of assessing the value of erections which takes account of their extent, disposition and the nature of the closing appliances has been adopted. Fig. 8 shows the present British freeboards compared with the committee's proposed freeboards in the case of a 400-foot vessel

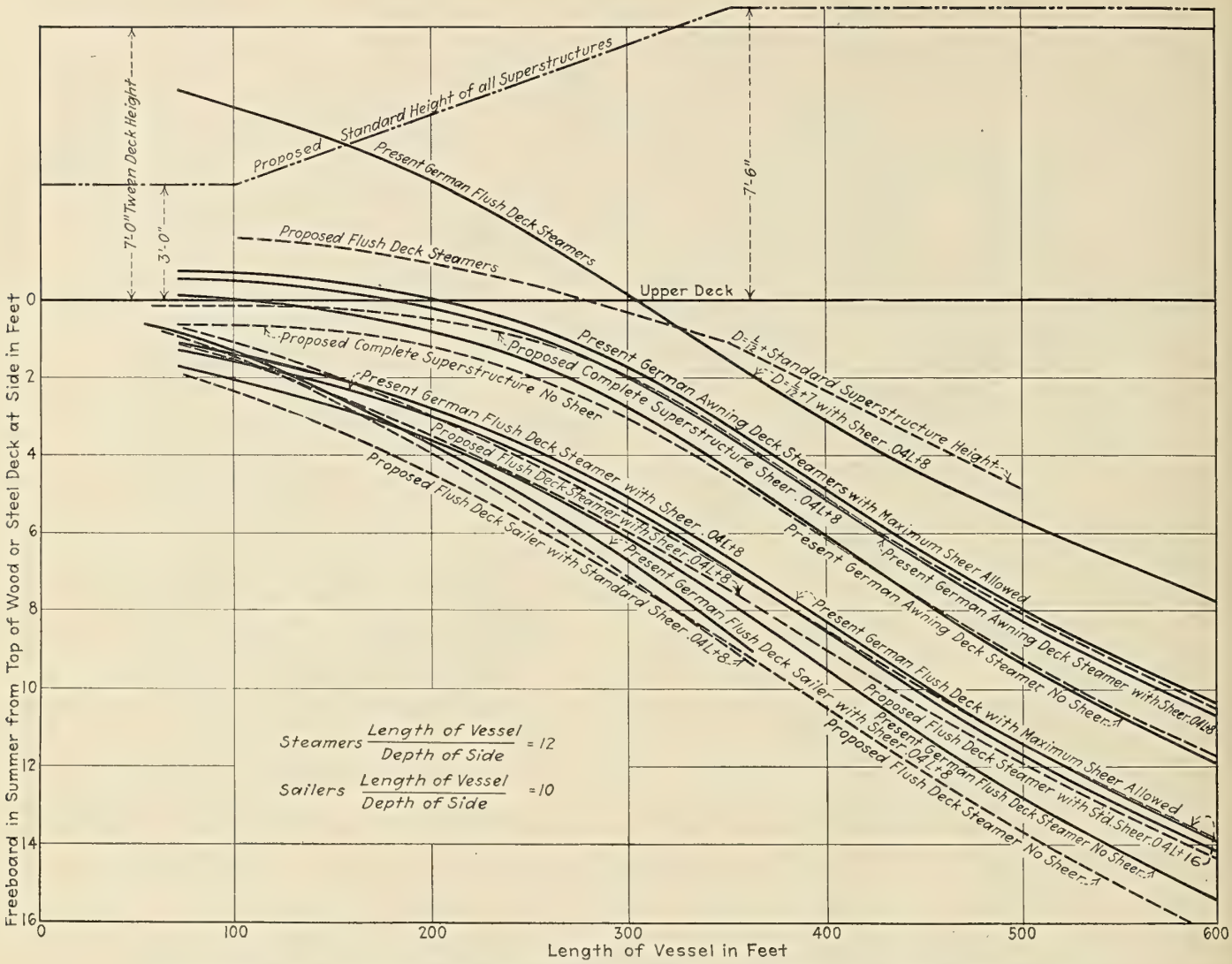


Fig. 7.—Comparison of 1915 Load Line Committee's Proposed Freeboards With Present German Freeboards

with different types of erections, varying proportions of $\frac{L}{D}$ and different mean sheers. The committee lays particular stress upon the necessity of providing adequate protection for openings, and instead of proposing to make additions to the freeboards of vessels on account of deficiencies in this respect conditions of assignment of freeboard are laid down with regard to the strength of machinery casings, hatches, ventilators, openings in the superstructures and in the sides, such as gangway doors, side ports, etc., which are an amplification of the present requirements.

Probably the most important part of the committee's work was the formulating of a new standard of strength to be used in association with the new freeboard rules. A technical staff was employed to carry out the necessary research work, and under the guidance of Professor Abell, of Liverpool University, now chief surveyor of Lloyd's Register, a very thorough analysis was made of ship structural practice as determined from the 1913 Rules of Lloyd's Register, British Corporation, Bureau Veritas and Germanischer Lloyd's, as it was considered that the classification rules, embodying as they do the results of years of experience, were good for a wide range of loading conditions. It was ultimately found possible to express by comparatively simple formulae the average minimum requirements of ordinary practice found from the above analysis.

The proposed standard of longitudinal strength is measured by the modulus of resistance of the midship section of the vessel computed by the usual methods. The standard $\frac{I}{Y}$ is found from the formula:

$$\frac{I}{Y} = f \times b \times d,$$

where b is the breadth of the vessel, d the extreme summer draft and f is a longitudinal strength factor tabulated in terms of the vessel's length. The $\frac{I}{Y}$ through a section in way of the midship deck openings must not be less than $.9 \times f \times b \times d$, so that provision is made for a definite standard of deck compensation abreast openings. Straight line formulae are given for determining the standard minimum thickness of side plating and the corresponding frame spacing for any length of vessel, together with a method for estimating the increase in shell thickness required for variations in frame spacing over the standard. As transverse strength is at least of equal importance to longitudinal strength it is gratifying to note that an endeavor has been made to lay down a minimum standard of strength for at least one of the transverse members of the hull structure, i. e., for hold framing, and that the proposed formula for the required $\frac{I}{Y}$ of the frame section takes account in some degree

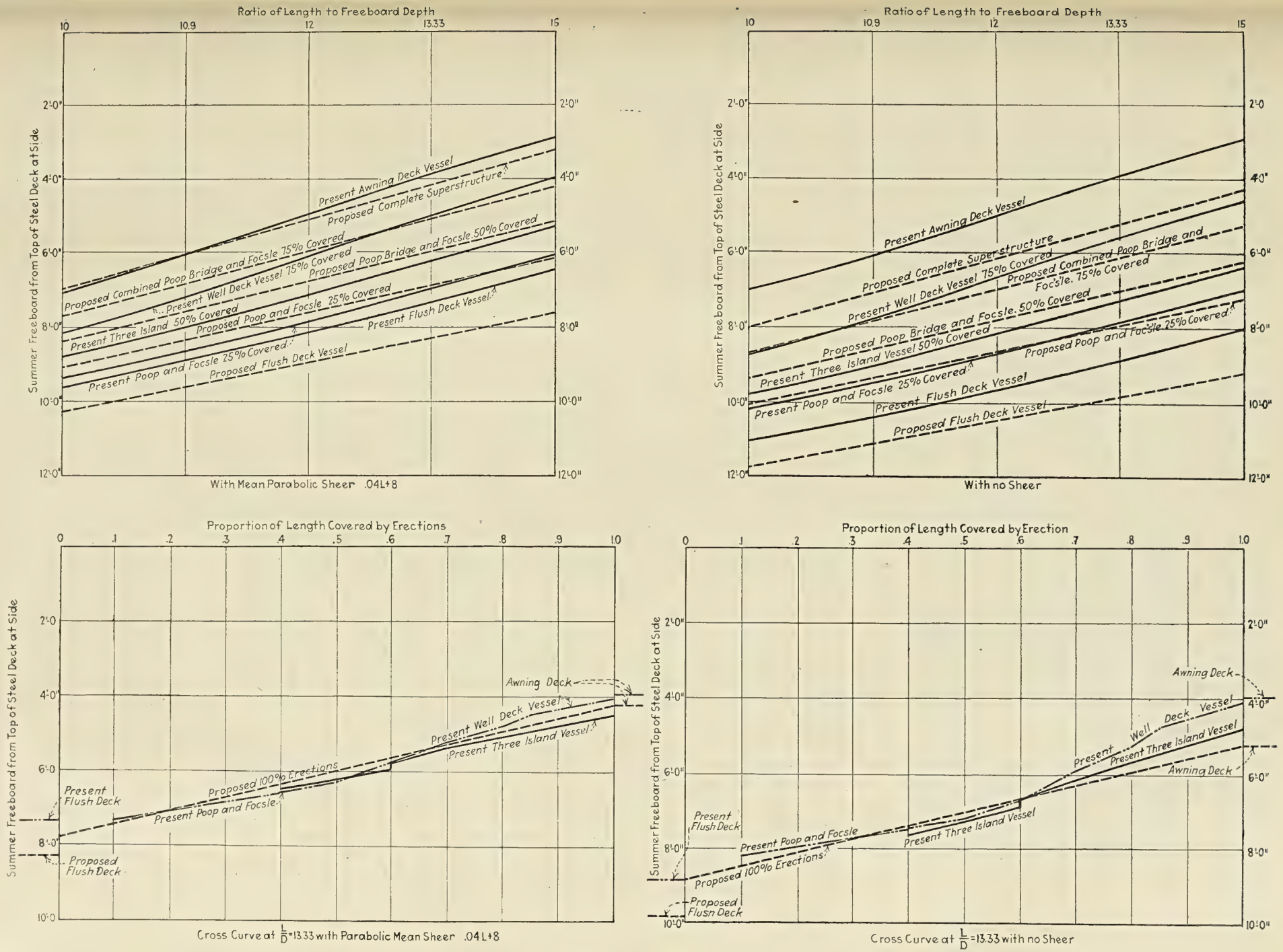


Fig. 8.—Comparison of Freeboards for 400-Foot Vessel With Varying Proportions of $\frac{\text{Length of Vessel}}{\text{Depth of Side}}$

of the principal factors which should enter into the determination of the frame scantlings, i. e., length of unsupported frames, spacing of frames, load draft and height of deck loads.

While the proposed standard of strength is probably satisfactory enough as far as it goes it is anything but complete, as a ship could be designed to comply with the new standard and yet prove very unsatisfactory from a structural point of view. Provided its limitations are understood, the proposed standard of strength should prove distinctly useful to naval architects, but it cannot take the place of classification society rules, as nothing is said about riveting and such important considerations as the bottom framing and the thickness of deck plating in relation to beam spacing. While the size of the frames as derived from the standard is affected by the height of the bracket floors the size of the beam knees at the lowest tier of beams is not taken into account in determining the modulus of resistance required, and although the necessity of providing sufficient stiffness in the frame apart from the $\frac{I}{Y}$ value is emphasized the necessary modifications to scantlings on this account are left to the assigning authorities. As the strength standards laid down are for vessels built on the ordinary transverse system, their application to longitudinally framed ships will also necessarily be left to the assigning authorities. No reference is made in the report to wooden or composite vessels, and this omission may have to be remedied in any international rules in view of the considerable amount of wooden tonnage still in existence.

The proposals of the 1913-15 load line committee undoubtedly represent a distinct advance over existing freeboard regulations. While there may be differences of opinion with regard to the theoretical basis of the strength standard, there is no question about the advantage possessed by the proposed rules over those at present in force in respect to the simplicity of arrangement, lack of ambiguity and ease in the actual working out of the freeboard and strength calculations. Since there can be no finality in freeboard rules any more than in rules for ship construction, it is also a distinct advantage that the proposed rules are in a form in which they can be readily amended if and when alterations are considered advisable. The proposed new regulations will mean that freeboards will be increased for practically all vessels where the openings in the terminal bulkheads of erections are not closed by class 1 appliances, and considerable increase in freeboards will result in the case of flush deck vessels, especially if the sheer is less than the new standard. The rules are a step in the right direction in respect to the emphasis placed on structural strength and conditions of assignment as to protection of openings which, however, can be easily and cheaply carried out in new construction. Since the publication in 1916 of the British load line committee's report sufficient time has elapsed to give the various freeboard authorities opportunity to compare the new proposals with existing freeboard regulations, and it is quite possible that the British authorities, in the light of their further experience, may now desire to make changes from the proposals of the load line committee.

This country is not handicapped by precedent in the matter of freeboard or load line legislation, so that the work of the American load line committee, of which Admiral Taylor is chairman and which is at present considering the entire subject, is of the highest importance. In this connection, although it has not been found possible within the limits of this paper to deal with other than the freeboards of ordinary seagoing freighters, it might be remarked that there are particular types of vessels which constitute a special problem for this country and which are being investigated by the several sub-committees formed for the Atlantic and Gulf coasts, Pacific coast and Great Lakes districts under the direction of Professors McDermott, Durand and Sadler with a view to making recommendations to the Secretary of Commerce.

RanD System for Bunker Oil

MEANS for reliquidizing oil in ships' inner bottoms without the use of heating coils are provided by the RanD system for bunker oil recently placed on the market by Row and Davis, Engineers, Inc., 90 West street, New York. This system applies forced circulation to the bunker oil by means of a central heater located in the boiler or engine room connected to a circulating pump (usually the transfer pump) and with discharge and suction connections at the deep tank and inner bottoms.

Each hot oil discharge connection consists of a nozzle constructed so as to rotate slowly in a horizontal plane, thereby causing agitation in every direction throughout the mass of cold oil in the tank compartment. These nozzles are installed through an opening cut in the tank top and in the case of vessels already built this can be done and the entire system installed without removal of oil from the inner bottom tanks. The deep tank connection is used to start the system and where the vessel is not fitted with a deep tank or settling tank a specially designed bulkhead connection is furnished to provide an auxiliary for temporary use in starting.

With this system an inner bottom tank 90 feet long has been handled with two discharge nozzles, one at each end of the tank. The exact number and location of the nozzles as well as the determination of the capacity and arrangement of the system are matters of special engineering for each installation and are decided after a thorough investigation of the plans and fuel requirements of the vessel considered.

The principal advantages claimed for the RanD system are as follows:

1. Circulation and effective reliquidizing of the oil are assured by the constant inflow of hot oil through the rotating nozzles and the constant withdrawal of cold oil to the heater.
2. The temperature of the oil can be positively controlled either manually or thermostatically, so as to prevent overheating and partial destructive distillation with loss in fuel value of the oil.
3. The system provides a flexible control of the oil temperature to meet changing conditions of sea water, weather, or grade of oil used. The circulation can be increased or decreased by changing the pressure of the oil at the nozzles and the temperature of the oil can be increased or decreased by changing the steam pressure in the heater.
4. A uniform temperature is maintained throughout each tank compartment, preventing any strata of congealed oil from diminishing the effective tank capacity.
5. There are no heating coils or other equipment in the tank compartments to reduce tank capacity, contaminate oil through leakage, increase maintenance cost through rapid wear and difficulty of repair, or overheat the oil.
6. The entire system (except the discharge nozzles) is outside of the tank compartment, in plain view, and readily accessible.
7. The system makes use of existing pipe connections and pump and can be installed at comparatively small cost and without removing oil from the ship's inner bottom. Repairs and replacements are normally few and readily made.
8. There need be no guesswork as to elements of design or arrangement of the system, because the circulation of oil which it produces is known to be positive and governed by definite calculations.

Vessels Delivered by Germany.—The total tonnage of vessels delivered by the Germans up to December 31, 1920, was 2,054,729 tons gross. The proportion representing sailing vessels was 25,325 tons. The amount of tonnage yet to be delivered is about 500,000. The Reparations Committee has delivered 1,814,173 tons as follows: To Great Britain, 1,477,839 tons; to France, 166,924 tons; to Italy, 124,901 tons; to Japan, 28,678 tons, and to Belgium, 15,831 tons.

Problem of the Hull and Its Screw Propeller*

Selection of Data for Hull and Propeller Design—Method of Making Corrections for Variations in Hulls—Appendage Resistance

BY REAR-ADMIRAL C. W. DYSON, U. S. N.

IN 1915 Sir Archibald Denny made the statement that in the future the rules for the correct designing of propellers should be derived from data carefully taken from the trials of smooth bottom vessels carefully run over accurately measured deep water courses.

Several years ago Admiral Taylor wrote to the effect that if theoretical formulas for design are adhered to it would be necessary to compare each formula with experimental results and select that one which seemed to agree more closely. Then, using this as a semi-empirical formula with constants deduced from experiments or experience, problems could be satisfactorily dealt with.

Both of these statements practically agree. Denny boldly casts all theoretical treatment of the propeller into the discard, while Taylor, by implication, takes the same action, only retaining enough of the theory to save its face, to use a Chinese expression.

To accept these statements of such eminent authorities at their full value throws us at once into the field of empirical results from which to derive data and formulas for the determination of hull forms and characteristics of propellers to fit any particular form of hull and the resistance which it may be desired to overcome.

Difficulties Encountered in Obtaining Reliable Data

Upon entering the empirical field for propeller data the investigator is at first encouraged by the large, apparently large, amount of data available, but it does not require any extravagant amount of time for him to ascertain that fully 95 percent of the available data is absolutely worthless, this statement of course referring to conditions where general formulas and constants for design covering the entire field of the combined problem, ships and their propellers, are being sought.

The principal causes of worthless data are:

(*a*) Lack of model tank trial curves for the ship.
(*b*) Variations in conditions of ship's bottom.
(*c*) Deep sea trials in place of measured mile.
(*d*) Variation in displacement and trim from those of model.
(*e*) Measured mile trials run in a tideway with insufficient number of runs for each spot.
(*f*) Trials run in shallow water.
(*g*) Model hull, when tried, not fitted with external appendages.

All of the above relate to the hull and the responsibility for them rests with the owner, the builder and the naval architect, all of whom, apparently, are so short sighted as to be able to see only the few dollars saved today by comparatively petty economies, losing sight entirely of the thousands of dollars which would be realized in the future were the small trial savings of today ignored.

Turning now to the propellers we find:

(*h*) Blade forms varying according to the taste of the designing engineer.
(*i*) Blade sections varying to the same degree as blade forms.
(*j*) Variations of pitch in a blade and in the blades of the same propeller.
(*k*) Blades abnormally thick and blunt.
(*l*) Blades exceedingly rough.
(*m*) Blades made with pitch expanding radially or axially, or both.
(*n*) Hub of such form as to cause abnormal eddy losses.
(*o*) Propellers so located with respect to the hull of the ship as to produce abnormal losses.

The guilt for all of these rests with the designer of the propeller. The naval architect is, however, *particeps criminis* in the last named offense.

Derivation of Fineness of After Body of the Ship

In making the selection of data upon which to base formulas and design data it is necessary to confine consideration to hulls of fine lines with propellers so placed that the chances of decrease in propulsive efficiency due to hull effect are reduced to a minimum. The propellers which are fitted to these hulls must all have practically the same radial distribution of the projected areas, must have the same general forms of blade sections, must be true to pitch, fine-edged and smooth, in order to eliminate as many variables as possible from the equations.

Variations in Hulls of Vessels

Suppose a vessel to have a certain set of forward and of after body lines with a parallel middle body of a certain percentage of length of the vessel. She will have a certain block coefficient. Now, maintain the same forward and after body lines, but modify the length of the middle body. As the length of the middle body increases over the initial length the block coefficient increases, and vice versa; but the after body lines, which control the character and quality of the flow of water to the propeller, have remained as at first. It is impossible, therefore, to base propeller conditions on block coefficient, but there must be provided a means of bringing measurements of block coefficient to a standard condition.

In the foregoing example the constants, in addition to the forward and after lines, are the beam B and the draft H, while the ratio $B \div L.L.W.L.$, or $B \div L.B.P.$, is variable.

Having obtained a means of correcting for the variable there will immediately be discovered another condition which contains the same variable as before, but, in addition, H has become variable. Experience has taught that with constant form and area of load waterplane, to decrease the draft of the hull is to increase the nominal block coefficient, but the wake will not increase but will remain practically the same as with the initial draft; while should the draft be increased the nominal block coefficient will be decreased, but, as in the opposite case, the wake will remain practically unchanged.

Having corrected for varying ratios of length to beam and of draft to beam, it might be considered that the coast has been cleared and that a position had been reached where the propeller could be taken up, but this is not the case. There is still a variable, and that a very important one, to take care of, namely, varying ratios of lengths of after body, or, if preferred to so call it, length of run to draft. This variable has a very strong effect on the wake, varying both the character and the quality of the flow of water to the propeller.

All of the varying dimensions now having been covered, it will be found that still another correction must be made, and that is the correction for type of hull. The types of hulls are sharply defined by the character of the after body lines as

* Paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1920.

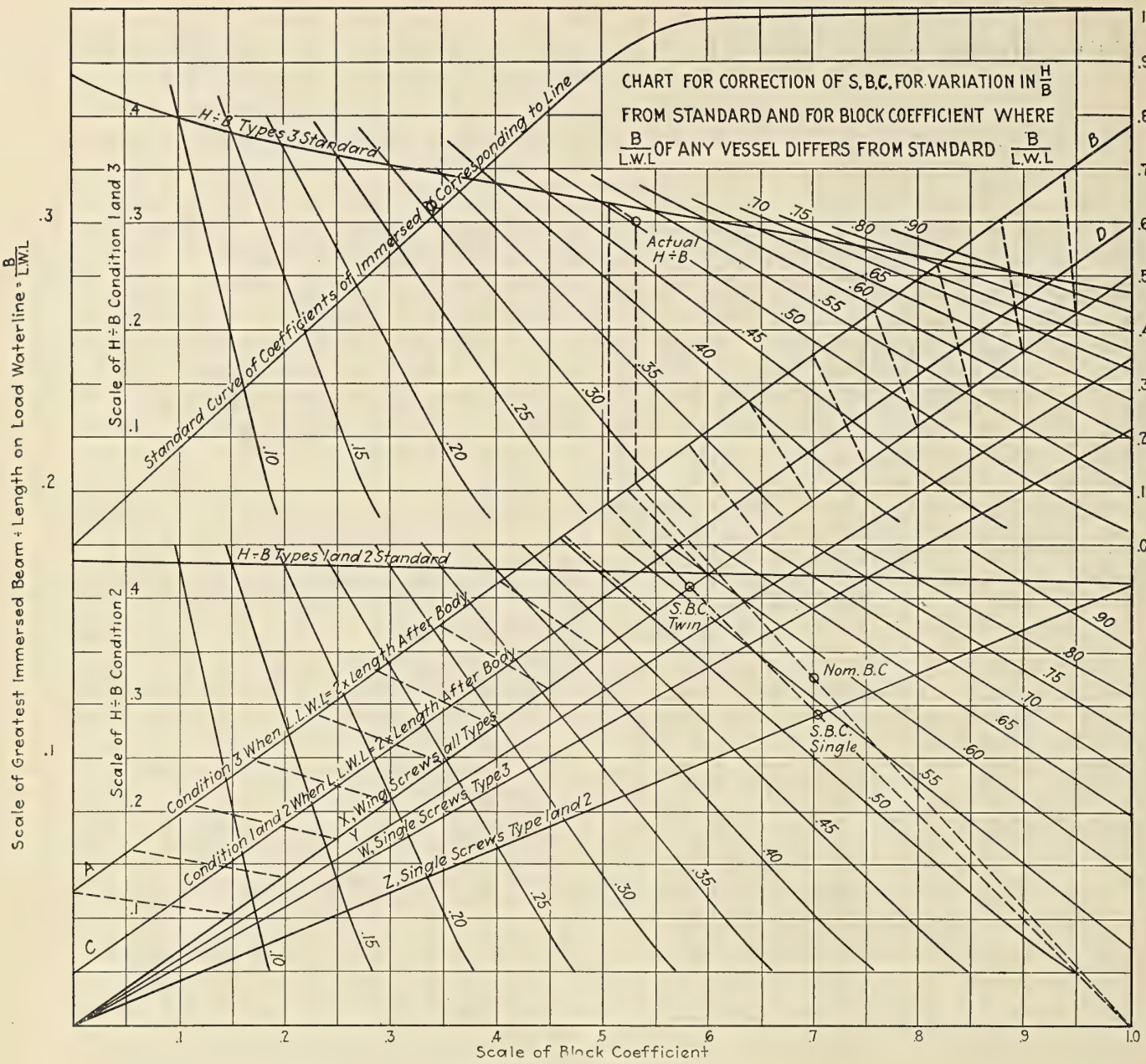


Fig. 1

the hull fines towards the stern, whether this fining is produced by a rapid dead rise of the bottom, with a very slow decrease in beam at the load waterline, or whether it is produced by a rapid decrease in beam. The latter type can be subdivided into two types, the first having a full and the second a fine midship section, the first tending to concave body section lines and the second to convex. In the first subtype the propellers are to a great extent, or entirely, covered by the submerged hull, while in the second subtype the propeller may be entirely outside the limits of the load waterplane. The first subtype will be spoken of here as Hulls of Type 1, and those of the second subtype as Hulls of Type 3.

Where the hull fines rapidly by means of a rapid rise of the bottom towards the stern the vessel is denoted as having a Hull of Type 2.

As examples of the different types the following may be taken:

Type 1—United States dreadnoughts and destroyers.

Type 2—Vessels of the ordinary fantail form of stern such as United States colliers and the ordinary type of merchant ship, also submarines.

Type 3—Vessels having the so-called cruiser stern; gunboats *Annapolis* and *Sacramento*, battleships of the *Virginia* class, battle cruisers, scouts.

Method of Making Hull Corrections

The determination of after body form or, as it may be expressed, the determination of the slip block coefficient of a ship, together with the effect of the variations of ratios of length, beam and draft, can be expressed graphically. With the exception of the correction for ratio of length of after body to draft, which correction is used rather for the correction of apparent slip rather than of slip block coefficient, the preliminary estimate of this coefficient, together with its correction for ratio of draft to beam and of length on load waterline to beam, for all the various hull conditions which may be considered as of normal form, are shown on Figs. 1 and 2.

On Fig. 1 the line X passes through the points whose abscissas are nominal block coefficients, while the ordinates are the ratios $B \div L.L.W.L.$ The value $L.L.W.L.$ may be replaced by $L.B.P.$ (length between perpendiculars) without any sensible error, as the entire method must be considered as one of approximation.

For the vessels of types 1 and 2 there is given a curve of

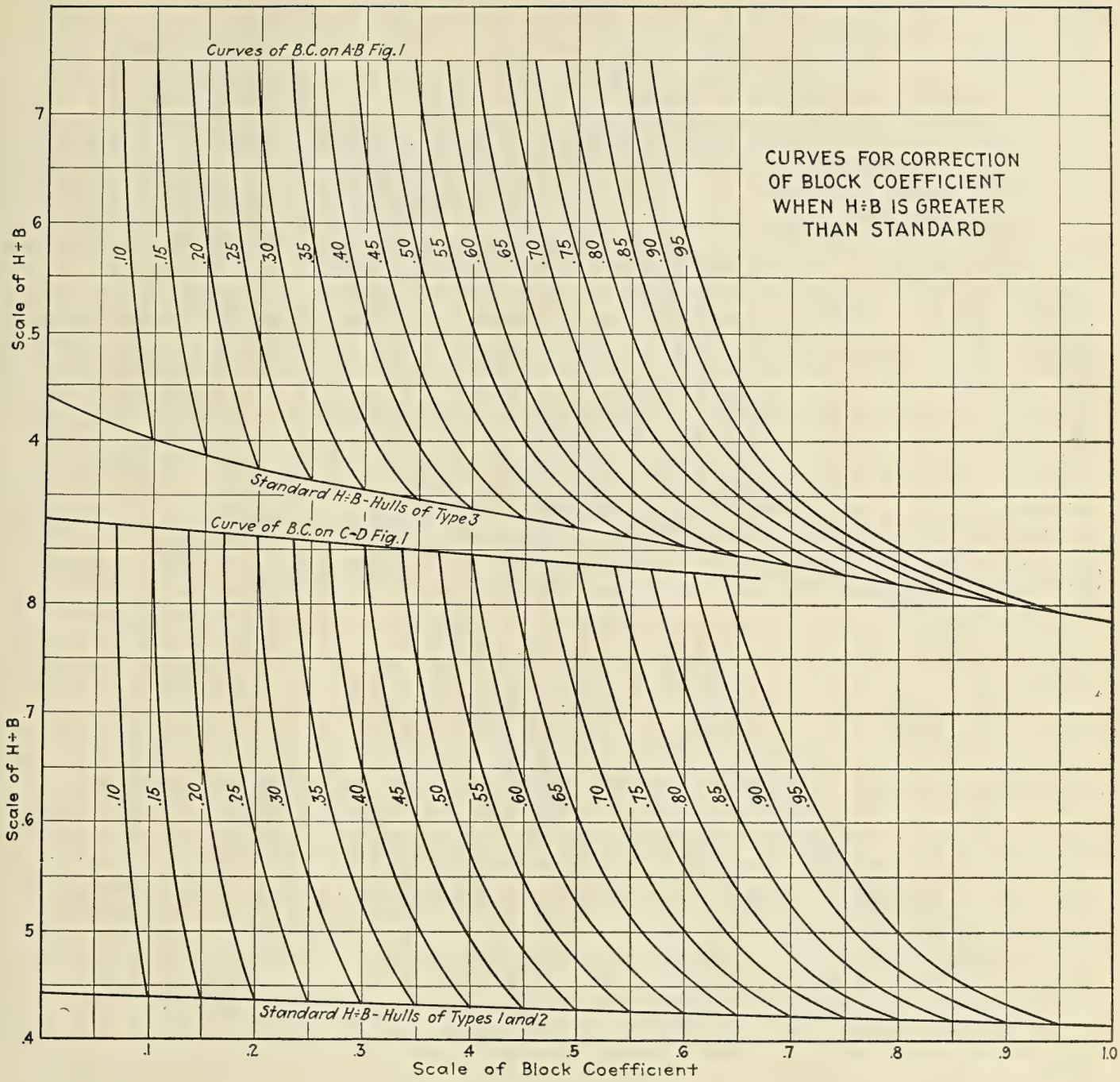


Fig. 2

coefficient of midship section, at the top of Fig. 1, for the block coefficients as given by the intersection of the diagonal through the plotted point of nominal block coefficient and the abscissa value 1 with line X. Where the coefficient of midship section for any block coefficient referred to line X is less than the standard for this referred block coefficient as given in Fig. 1 the after body form approaches the form for type 3.

Correction for $B \div L.L.W.L.$

Of the standard hulls chosen on which to base the chart, those of type 3 had short middle bodies which, when eliminated, would have raised the ratio line of $B \div L.L.W.L.$ to AB, while those of types 1 and 2 would have raised this ratio line to CD, the nominal block coefficients decreasing in both cases. Now let it be supposed that the forward and after bodies remain constant but that the length of the middle bodies be varied. As this length increases the nominal block coefficient will increase until at length the effect of the fineness of the forward and after bodies on the value of the nominal block coefficients will become inappreciable so that the nominal block coefficient as calculated will be unity. On the other hand, the middle body may be entirely eliminated when the nominal block coefficient will be that of the combined fore and after bodies only. These changes of nominal block coefficient will take place approximately along straight lines passing through the plotted point of nominal block coefficient and the point of 1.0 on the scale of abscissas where the ordinate $B \div L.L.W.L.$ is zero. The equation to these lines is:

Nominal block coefficient on

$$X = \frac{B \div L.L.W.L.}{.28\,(1 - \text{Nom. } B.C.) + (B \div L.L.W.L.)}.$$

Now the line X is for slip block coefficients of standard twin screw ships of all the types and the standard block coefficient for single screw ships of type 3 would be that where the line through the plotted position of the actual ship crosses the line W, while for type 2 and type 1 it would be at the point of crossing of the line Z.

Should the vessel have four shafts, for vessels of standard

ratios of $H \div B$ and $2L.A.B. \div H$, the slip block coefficient for the outboard propellers will be the intersection of the correction line with the line X and for the inner propellers the intersection with the line Y. Should the ratio $2L.A.B. \div H$ be much greater than the standard, the above corrections will be reversed. As it takes quite a large variation in slip block coefficient to make a heavy variation in revolutions, this correction for position may be neglected without serious error and the point on X only be considered.

Correction for Variations in $H \div B$

The ratios $H \div B$ for type 3 ships, corresponding to the nominal block coefficients as given by line AB, are given by the curves on Figs. 1 and 2, marked $H \div B$, type 3 standard, while those for types 1 and 2 vessels are given by the curves on the same figures marked $H \div B$, type 2 standard. There will be noted diagonal curved lines extending from above at the left to below at the right of the figures, marked with the values of the nominal block coefficients as taken from line AB for type 3 and from CD for types 1 and 2. These are direction lines to follow in correcting for values of $H \div B$ less than standard on Fig. 1 and for greater than standard on Fig. 2.

Example Illustrating the Above Method of Estimating the Slip Block Coefficient of a Vessel

To illustrate the above, two vessels will be taken:

Vessel A

Nominal $B.C.$ =	.632
$B \div L.L.W.L.$ =	.16
$H \div B$ =	.3
$2L.A.B. \div H$ =	14.66
Coefficient of midship section =	.930

Examination of the after body lines discloses that these lines fine rapidly due to a rapid falling away in beam and are convex. This indicates that the hull is of type 3 form.

Vessel B

Nominal $B.C.$ =	.7
$B \div L.L.W.L.$ =	.13
$H \div B$ =	.5
$2L.A.B. \div H$ =	13.5
Coefficient of midship section =	.98

Examination of the after body lines discloses that these lines fine rapidly due to a rapid decrease in draft of the actual full body of the hull, the beam being decreased very slowly as the stern is approached, while the screw is completely covered by the hull in the case of twin screws. These conditions, in conjunction with any value of $H \div B$ indicate a hull of type 2.

Vessel A, Type 3

Plotting vessel A on Fig. 1 with a nominal block coefficient of .632 and a value of $B \div L.L.W.L. = .16$, and drawing a line through this plotted point and the point on the base line where $B.C. = 1.0$, this line is found to cross the line AB at $B.C. = .535$. Erecting an ordinate from this point on AB to the value of $H \div B = .3$ below the curve $H \div B$, type 3 standard, and following the direction lines up to this curve, the corrected $B.C.$ on AB is found to be .505. Through this point .505 on AB draw another line through the base at 1.0. Where this line crosses X, which is at an abscissa value of .585, will be the corresponding corrected value of the $B.C.$ for wing screws, while where it crosses W, at .64, will be the $S.B.C.$ for a single screw vessel or for the center propeller of a multiple shaft vessel with an odd number of shafts.

Should the vessel be fitted with wing propellers a correction should be made for variation of midship section coefficient from standard by multiplying the value of the $S.B.C.$, line X, by the ratio actual midship section coefficient $\div$ standard coefficient.

Vessel B, Type 2

Turning now to vessel B, passing the line through its plotted point, nominal $B.C. = .7$, $B \div L.L.W.L. = .13$, and

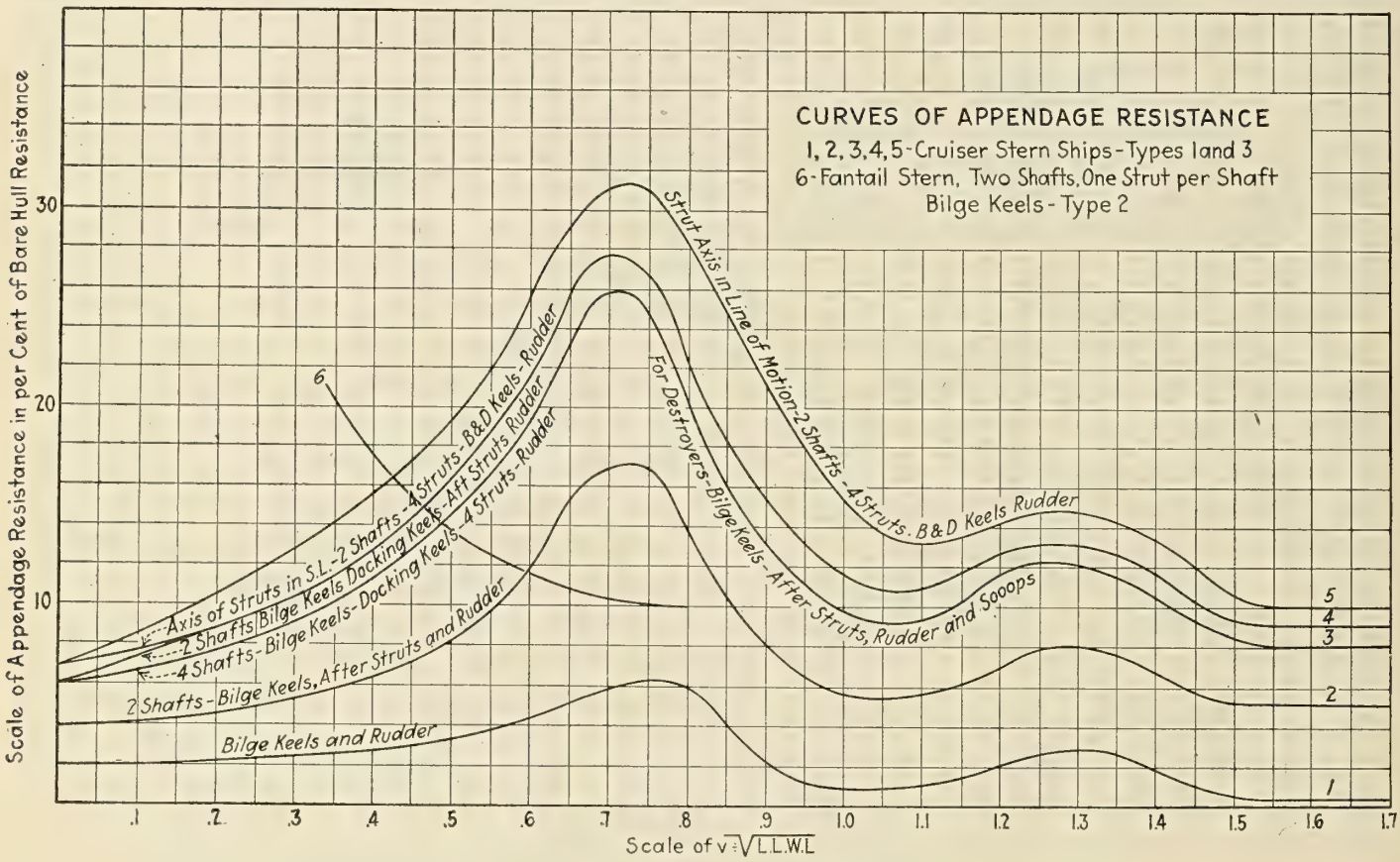


Fig. 3

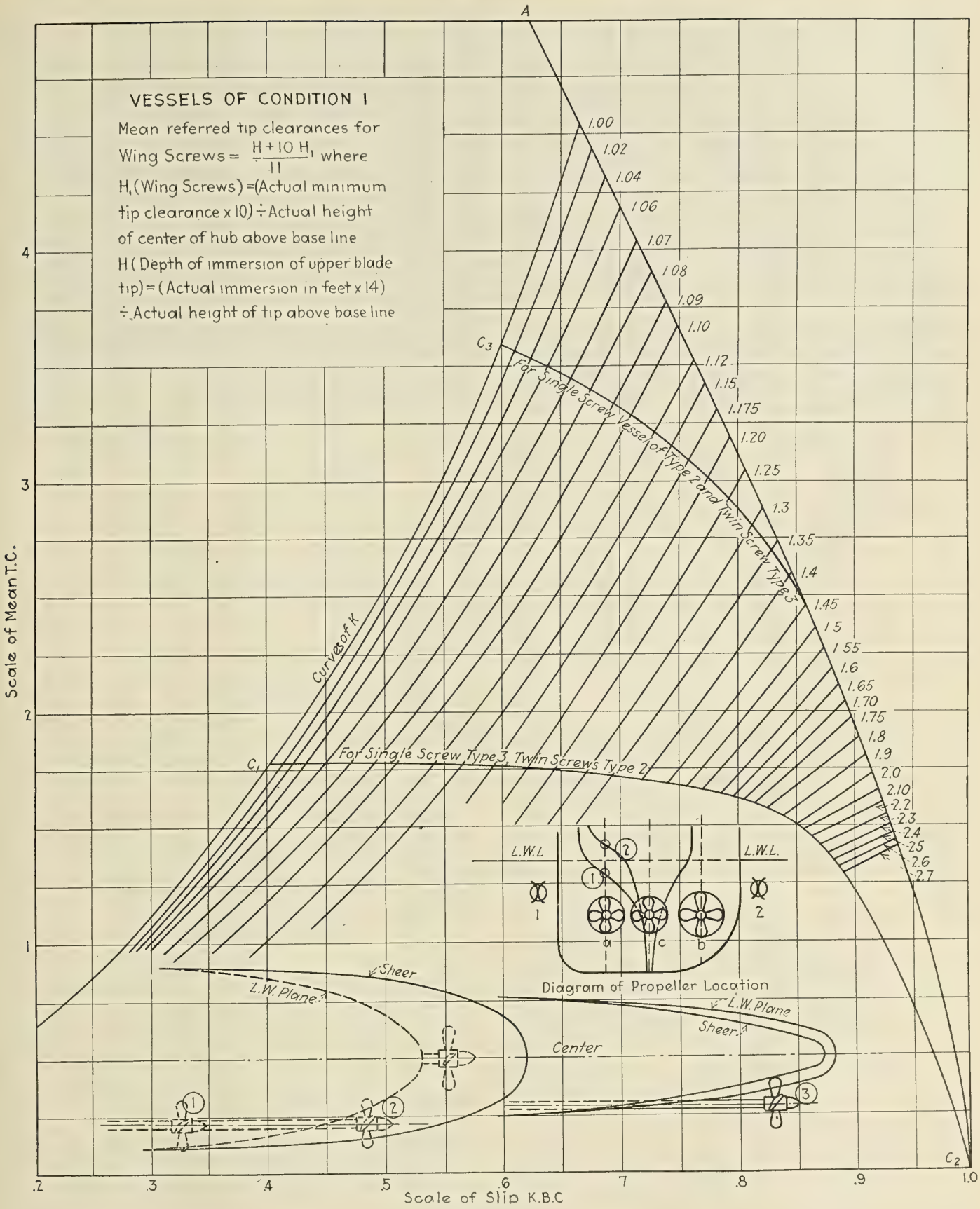


Fig. 4

abscissa value 1.0, and extending the line to *CD* it will be found to cross this line at the *B.C.* value of .582. On the curve marked $H \div B$, condition 2 standard, the value of $H \div B$ is found to be .423; therefore, the actual value of $H \div B$ being greater than this standard, turn to Fig. 2 and plot the point $H \div B = .5$, $B.C. = .582$ above the lower standard $H \div B$ curve, and from this plotted point follow the curves of direction down to this standard line. It will intersect this line at $B.C. = .675$. Through $B.C. = .675$ on *CD* and abscissa unity again draw a line. Where it intersects *X*, at $B.C. = .697$, will be the *S.B.C.* for twin propellers, while where it intersects *Z*, at .797, will be the *S.B.C.* for a single screw ship, that is a vessel with a single propeller on the centerline of the hull.

Vessel C, Type 1

In vessels of type 1 the determination of *S.B.C.* is made as for type 2.

With vessels of this type the character of the wake appears to be nearly similar to that for type 2, while quality is more nearly like that of type 3.

By character of wake is meant the degree of obliquity of flow of the water to the propeller disk, while by quality of wake is designated the degree of disturbance of the wake and general decrease in its density due to contained air in the water in which the propeller operates.

Conditions of wake are the most favorable with ships of type 1, less so with ships of type 3, and decidedly unfavorable with ships of type 2, although it may be claimed that vessels of this latter type carry much heavier wakes than do the other types and more gain should therefore be realized from the wake than with the other two types. This claim would be a just one were the quality of the wake with the vessels of this type with which designers ordinarily have to deal equal to that experienced with vessels of the other types.

It has been attempted in the foregoing to give a slight idea of the difficulties in arriving at the very foundation of the screw propeller problem before the propeller can even be approached. It is hoped that it has also shown the absurdity of basing any propeller design upon nominal block coefficient without correction. In connection with this the author had the rather amusing experience of being approached by a gentleman with the question as to how he "would determine the slip block coefficient of a vessel to use by looking at her in the dry dock." The same gentleman also made the statement that he was able to determine by inspection the proper diameter and pitch of propeller for any given hull.

It will now be necessary to say a few words concerning the resistance to be overcome by the propeller in driving the hull through the water.

Resistance—Hull and Appendages

The question of hull resistances being so fully understood, it is only necessary to state that for propeller work, in developing a system for design purposes, only such vessels should be used as have had their resistances determined by towing the model of the hull in a model basin.

It does not suffice to tow the model of the bare hull, but this model should be fitted with all external submerged attachments in order that the true resistance of the hull may be arrived at.

Fig. 3 shows curves of appendage resistance in percentage of bare hull resistance, erected on values of speed of vessel $\div \sqrt{L.L.W.L.}$ as prepared by the writer from the reports of trials of models in the model tank at Washington. These curves are rough approximations, as the actual appendage resistance varies with the form of hull and the amount of power carried by the hull and also with the revolutions at which the propellers are to run, these latter two factors fixing the size of shafting, external lengths of shafting and size of propeller struts.

Propulsion Losses Due to Type of Hull and to Location of Propeller in Respect to the Hull—The Power Augment Factor *K*

It is a little premature to speak of these losses at this stage of the investigation as they really cannot be studied until the primary design curves have been arrived at, and this result can only be reached by selecting for the early investigations such vessels as, from the high values of the propulsive coefficients obtained, are decided upon as having all such losses reduced to the smallest possible minimum.

The losses, other than those due to poor workmanship in the propeller itself, arise from the reduction in pressure in the area in which the propeller operates and also from the obliquity of flow of water to the propeller caused by the fullness of lines of the hull interfering with the flow. There may also be serious losses due to eddying around improperly formed stern and rudder posts, around struts of improper section and arrangement, around and between strut bosses and propeller hubs, around the hub itself and to excessive roughness of surface of the propeller blades and excessive variation of pitch between different blades of the propeller or throughout each blade. Of course these latter named losses are due to poor workmanship and can easily be avoided by care in casting, finishing and setting the propeller blades.

The loss factor or power augment is given the letter K to denote it. In previous works of the author this letter K has been spoken of as the thrust deduction factor, but this does not convey all that K represents, which, in fact, are the losses which have just been given.

The K factor has the minimum values for hulls of type 1, but these values for this type increase very rapidly as the tip clearance diminishes after a certain limit of tip clearance between the hull and the circumference of the propeller disk has been reached; this distance, so far as the author can determine, being dependent upon the draft of the vessel and the height of this minimum distance above the base line. The formula for obtaining this mean tip clearance is expressed by

$$M.T.C. = \frac{H + 10H^1}{11}$$

where H^1 (wing screws) = (actual tip clearance $\times$ 10) $\div$ (actual height of hub center above base line) and H = (actual immersion of upper blade tip in feet $\times$ 14) $\div$ (actual height of tip above base line in feet).

Hulls of type 3 stand next in order of loss, while those of type 2 are the heaviest losers, single screw ships of type 3 having the same loss factor as twin screw ships of type 2.

The values of K for the different classes of hulls are shown on Fig. 4, the ordinates being mean referred tip clearances for type 1, while the abscissa values are values of K block coefficient, *K.B.C.*, which are obtained from Fig. 1 by taking the intersection of the line through the plotted point nominal *B.C.* — $B \div L.L.W.L.$ and the abscissa point of unity with X, W or Z, according to whether the vessel is a wing or single screw ship. The block coefficient value of this intersection is the *K.B.C.* for the vessel. The values given by Fig. 4 hold very closely for all vessels of what may be considered normal dimensions. For vessels having extremely great ratios of length of after body to draft they may possibly decrease to some extent, but there are no data of sufficient accuracy to enable this to be stated definitely.

(*To be continued.*)

The Shipbuilding Capacity of Germany.—Herr Phillip Heineken, the retiring chief of the North German Lloyd, in an article to the Norddeutscher Lloyd Year Book, stated that for the next few years the amount of building of new vessels by Germany for her own requirements will not be worth mentioning. He says that the 1913 output of German shipyards amounted to over 500,000 tons per annum, but other estimates state that the output now can be increased to 7,800,000 tons, in view of the erection of new yards during the war and the conversion of naval yards to construction for mercantile purposes, so that, even after deducting the 200,000 tons per annum to be built for the Entente during each of the next five years, a resulting increase in the output of German tonnage may be expected. Herr Heineken considers these figures to be exaggerated and points out that the factors which counteract such optimistic views are scarcity of coal and ores, excessive rise in wages and general working costs. Many years will pass before German shipyards will be able to cover, even approximately its own requirements, and until they are in a position to do so they cannot avoid leaning upon foreign shipping companies to a certain extent.

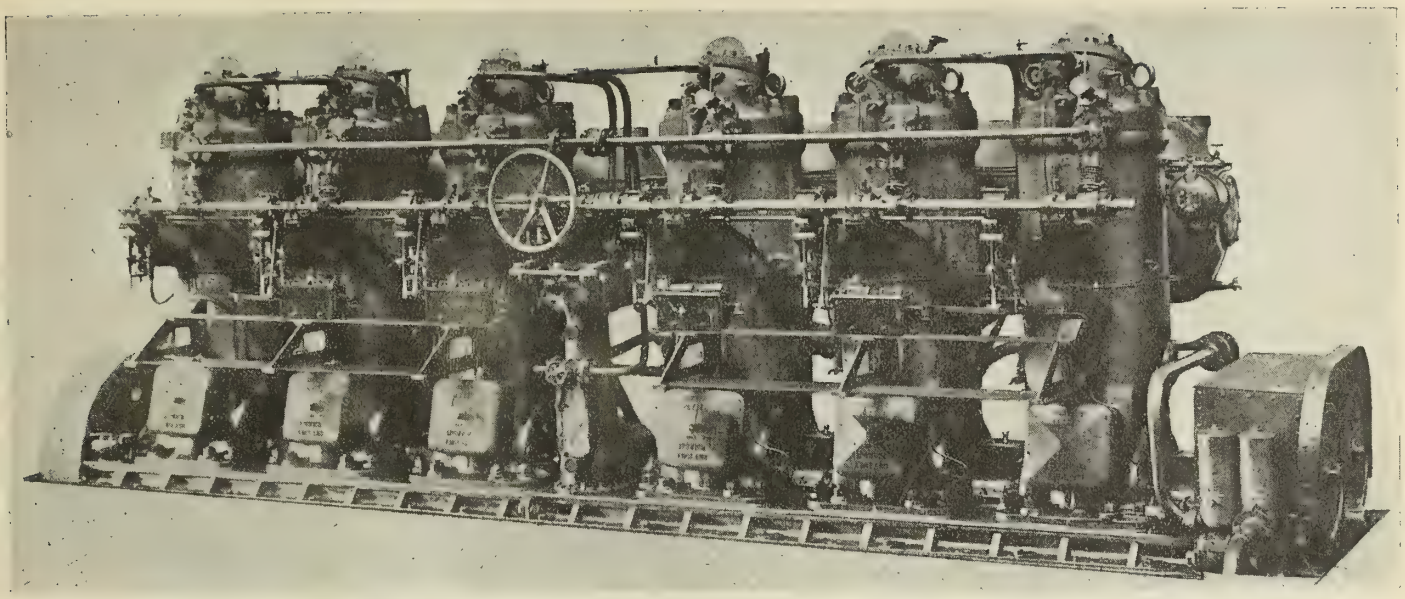


Fig. 1.—Vickers-Petters Semi-Diesel Engine, 500 Horsepower

Two Versus Four Cycle Diesel Engines

Competition Between Manufacturers of the Two Types in Europe Becomes Lively—Fast Cross-Channel Motorship Proposed

BY OUR SPECIAL LONDON CORRESPONDENT

SIGNS are not wanting that the struggle which was bound, sooner or later, to occur between manufacturers of the two cycle and four cycle types of Diesel engine, is about to commence in earnest. One of the most significant facts in this connection is that many of the large shipbuilding concerns in the United Kingdom which are mainly engaged upon the construction of high powered vessels, such as passenger liners, have decided to adopt the two stroke type. For instance, in this category come John Brown and Company, William Denny and Brothers, Alexander Stephen and Company on the Clyde, and Armstrong Whitworth, Wallsend Slipway and Engineering Company, Swan, Hunter and Wigham Richardson and Doxfords on the North East Coast, in addition to Cammell Laird of Birkenhead. Dennys, Armstrongs, Cammell Laird, Stephens, and Swan Hunters are all now finishing their first motorships equipped with two cycle machinery and before the end of the year it is anticipated that detailed figures will be published showing the advantages which the manufacturers of this type claim for it in comparison with four cycle machinery.

Port Scavenging Two Cycle Engines

A point upon which great stress is being laid at the present time is that two cycle Diesel engines fitted with port scavenging can utilize any grade of oil available, even that which is commonly burned under boilers, whereas four cycle machines must necessarily have a lighter and more expensive fuel on account of other difficulties which may otherwise be encountered with the exhaust valves. This is a matter of extreme importance, for the shipowner whose vessel is equipped with a motor capable of consuming any available oil is clearly at an advantage. Recent tests show that the new Doxford engines run extremely well on Mexican fuel oil with a consumption of about 0.43 pound per brake horsepower hour while similar trials on Sulzer two stroke engines give a consumption very little higher. If these results can be confirmed in actual service at sea, it can scarcely be questioned that the popularity of the two cycle engine will increase by leaps and bounds.

There are some remarkable projects afoot in connection with the installation of two stroke engines in large vessels. It will not be long before the first large transatlantic passenger liner is ordered by one of the best known British shipowning firms which is holding the matter up on account of the general belief that shipbuilding prices will have to fall to a considerable extent in the next month or two. For the same reason the 16,000 horsepower motor passenger liner for the Swedish-American Line will not be laid down for a few months.

A 25-Knot Cross-Channel Motor Mailboat

Another and extremely interesting order which will be placed at no distant date is for a cross-Channel passenger and mail boat with a speed of about 25 knots. Hitherto these vessels (for service between England and France) have been mainly equipped with steam turbines but it is considered that even in Europe, where the price of oil is high compared with coal, a motor vessel of this type will prove more economical than the steamer. The power required is 10,000 brake horsepower and it is proposed to use two high speed submarine Diesel engines of the Sulzer type. Engines of this design developing 4,000 brake horsepower have recently been built for the Japanese Navy and there is nothing at all experimental in their construction. They have six cylinders and run at 350 revolutions per minute and it is estimated that the weight and space occupied with Diesel machinery in a cross-Channel boat will be considerably less than when geared steam turbines are adopted.

In an ordinary ship no engineer would recommend the installation of high speed Diesel engines but in cross-Channel boats where the machinery is operated only perhaps three or four hours daily and where constant attention can be given, there seems to be no reason why they should not prove entirely successful. A feature of this plant will be the adop-

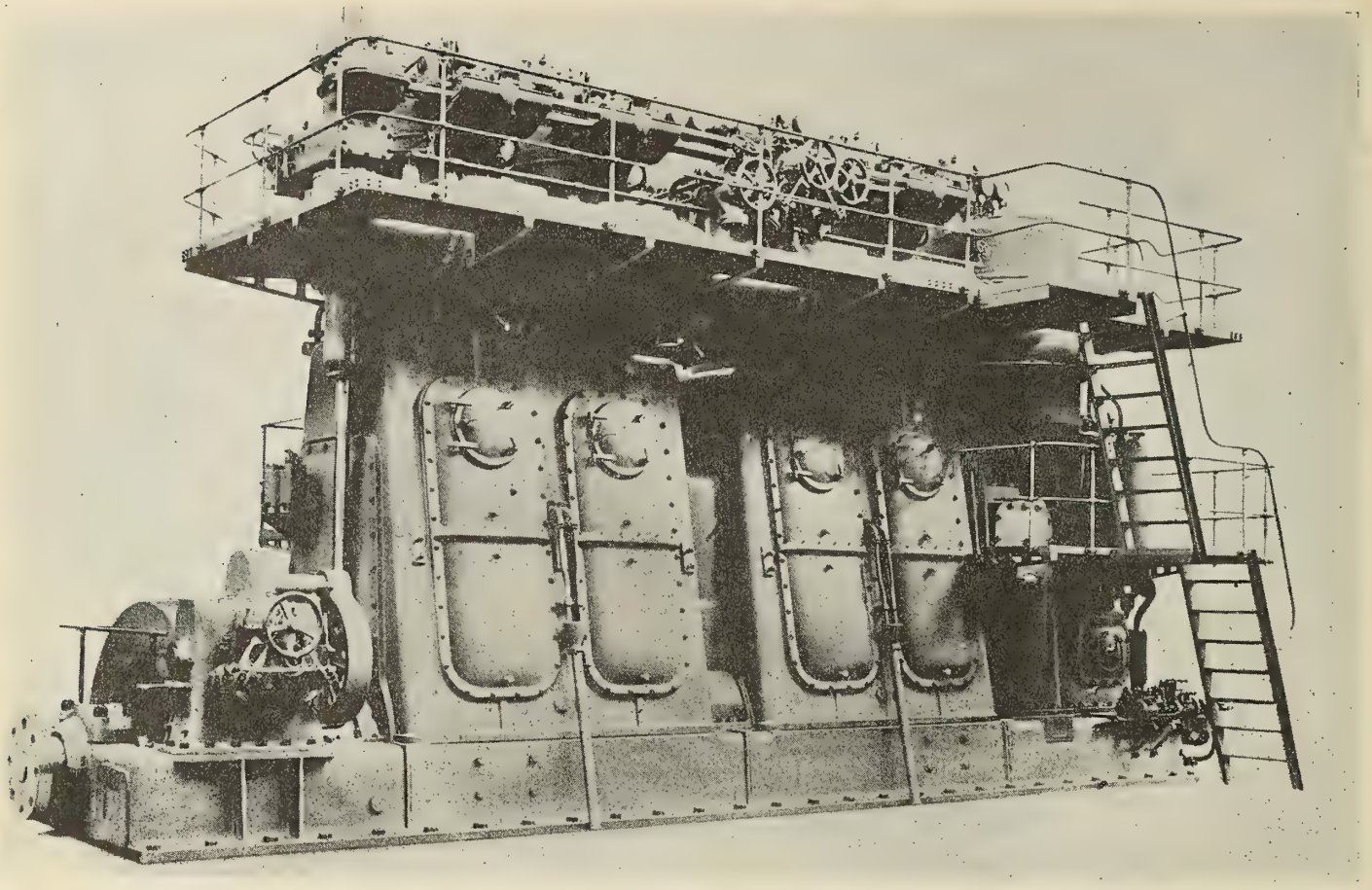


Fig. 2.—Two-Cycle Sulzer Marine Engine, 1,250 Horsepower

tion of turbo scavenging pumps driven by electric motors, this being a system which Sulzers have standardized for all high powered sets. The scavenging air is then supplied separately and the volume and pressure are independent of the speed of the engine while it can be warmed when starting up. According to recent tests the consumption of power for the auxiliaries including the scavenging pump and the air compressors is just over 10 percent of the engine output.

13,000-ton Standard Motorships

Depression in the shipbuilding industry and the cancellation of orders are having comparatively little effect upon motorship developments. No orders for internal combustion engined craft have been countermanded nor is work being held up since the shipowners are far-sighted enough to see that in times of slumps it is the motorship which is the better profit earning proposition. The East Asiatic Company, the pioneer motorship owning firm, is proceeding as rapidly as ever possible to build up its fleet of oil engined vessels on a larger scale than any other European concern. Two more 13,000-ton ships (sister vessels to the *Afrika*) have just been launched in Denmark, named the *Malaya* and the *Java;* both are for the East Asiatic Company. Previously, practically all the East Asiatic Company's contracts were placed with Burmeister and Wain but this firm has so many motorships on order that the East Asiatic Company was forced to place its orders elsewhere and the *Malaya* was therefore built at the Nakskov yard, where seven other motorships are also under construction for the same firm. Altogether it is stated that the East Asiatic Company has contracted for some 15 or 16 motorships, six of which will have a deadweight carrying capacity of 13,000 tons while several will be considerably bigger.

The *Malaya* and the *Java* are practically similar to the *William Penn* recently built for the United States Shipping Board and are equipped with a couple of the standard 2,250 indicated horsepower Burmeister and Wain four cycle motors. The fuel consumption of the sister ship *Afrika* works out at approximately 14 tons per day, which is certainly a very moderate figure for a ship carrying 13,000 tons of cargo at a speed of 12 knots.

New German Motorships

Germany having handed over most of her steamers to the Allied Powers under the terms of peace is now apparently commencing to build up a new mercantile fleet a large part of which will be propelled by oil engines. Very little information is available as to what is happening but it is known that many of the craft being built by Blohm and Voss and at the Howaldtswerke at Kiel are to be engined with internal combustion machinery, and at the latter yard two hulls are approaching completion, in each of which a couple of 1,250 brake horsepower Sulzer two cycle engines will be fitted. These engines, one of which is shown in Fig. 2, are being built in Germany at the Ludwigshaven Works of Sulzer Brothers.

Blohm and Voss and Krupps are both building their own machinery for installation in motorships and it is understood that the former is manufacturing double acting Diesel engines somewhat similar in design to those which were fitted in the motorship *Fritz* recently handed over to the British Government.

There has always been a strong belief in Germany in the possibilities of the double acting two stroke motor and it will not be surprising if some noteworthy developments transpire within the course of the next few months. The two motorships now being built at Howaldtswerke are cargo boats for the Hamburg-South America Line and will each have a deadweight carrying capacity of about 9,000 tons. They are to trade between Hamburg and South American ports.

There is a tendency among European engine builders to increase the size of semi-Diesel engines and to bring them into competition with Diesel motors for vessels up to 3,000 tons deadweight capacity. One firm is experimenting with a 1,000 horsepower four cylinder hot bulb set, Beardmores are building the same type up to 600 brake horsepower and Vickers Petters are now constructing 500 brake horsepower motors of six cylinders, one of which is shown in Fig. 1.

This is one of the first six cylinder European semi-Diesel engines that has yet been constructed although some of the type were built in America. It is of course directly reversible by means of compressed air, the whole of the reversing operation being carried out by means of the handwheel seen in the center of the engine. The rotation of this wheel causes starting air valves to be opened, admitting starting air to the right cylinders for turning in the ahead or astern direction as may be required.

The engine runs at 250 revolutions per minute and has cylinders 16½ inches diameter by 19 inches stroke and is fitted with the Vickers quick starting system by which it is possible to start from cold in about three minutes. In this respect therefore it suffers little disadvantage as compared with the Diesel type. Its chief novelty apart from the employment of six cylinders lies in the bilge and circulating water pumps seen on the right, which are run at very slow speed, having been geared down to about 90 revolutions per minute.

Gravity Type Lifeboat Davits Installed on Passenger Vessels

Among recent developments in lifesaving equipment is the gravity type lifeboat davit which is being installed on the eight new ships of the Holland-America Line. This device is being demonstrated in the United States by the International Nautical Trading Company, the head office of which is at No. 3 Kanaalstraat, the Hague, Holland.

Fig. 1.—Boat Being Swung Out Against a List of 15 Degrees

Under the Schat system, so called after its inventor, the lifeboat rests in two chocks each of which consists of two parts fixed to the deck which form points of support for a rotary moving section mounted between them. The pivot for this rotating part is out of line with the keel of the boat so that collapsible members of the chocks are inclined at all times ready to collapse. A cam hook for one or both chocks prevents their collapse until they are to be put in operation when a slight force applied to the locking mechanism releases the apparatus. The in and outboard grips are fixed on slip hooks which open towards the water side of the vessel.

The davits are mounted in frames which permit them to rotate and the lifeboat lies between them in the chocks in such a way that the lower part of the davits is at any desired angle usually about 20 degrees from the perpendicular to the deck. Because of this angularity with the vertical line, the davits have a tendency to swing outboard as soon as the lifeboat is released from the chocks and a special brake is fitted on the straight part of the davit near the lower bearing to control this rotating speed in such a way that the davits may be stopped at any required position.

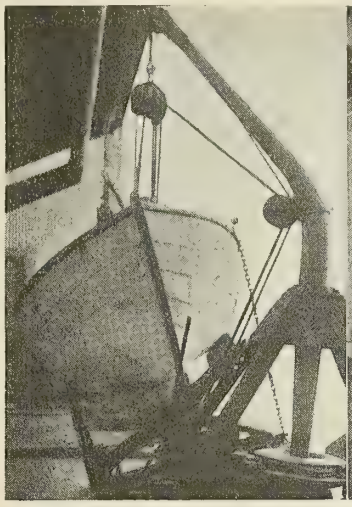


Fig. 2.—Boat Lying in Chocks Listed 15 Degrees

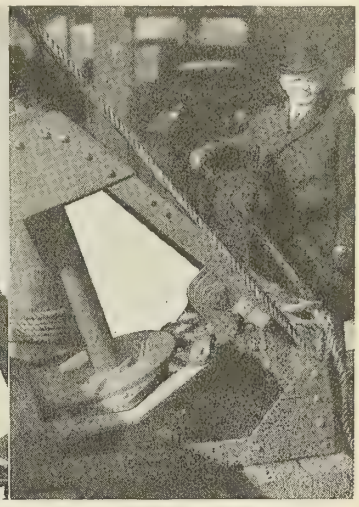


Fig. 3.—Showing Hand-Operated Braking Mechanism

The upper block is not connected to the davit head but is suspended to a wire rope which is in turn connected by means of a bell crank and brake levers to brake shoes so arranged that they can at will be forced into grooves of the disk brake which controls the rotation of the davit.

When it is desired to put the apparatus in operation the movable parts of the chocks are freed and collapse under the lifeboats' weight so that the boat hangs free from the toggles. The brake shoes of the davits then come into operation and, when released the davits swing outboard by gravity. Since the davit heads move in a downward direction the grips are allowed a slight amount of slack so that they are released from the slip hooks without the necessity of loosening the slip hooks, stretching screws, etc.

Shipbuilding in Australia.—The Melbourne correspondent of the *Times Trade Supplement*, London, states the former Controller of Shipbuilding, Mr. H. W. Curchin, has informed the Government of Australia that the cost of construction in Australia is considerably lower than in Great Britain. He states that the type of vessel now being built in Australia by the Government would cost about £32 (approximately $128 at the present rate of exchange) a ton, whereas the cost in Australia was only £28 ($112) a ton. The Minister for Home and Territories, Mr. Poynton, who controls shipbuilding operations in Australia, said that the cost of the latest vessel launched from the Williamstown yards was £25 ($100) a ton, and when ready for sea the cost would be about £28 ($112) a ton. Commenting on statements that some of the piece workers at the Williamstown shipyards were earning very high wages, the Minister stated that the average wages earned by boiler makers on piece work were from 28 shillings ($5.60) to 30 shillings ($6) a day.

Standardized Diesel Engines—II*

Discussion of Construction Involving Four Valves in Cylinder Head—A Maneuvering Compressor

BY H. R. SETZ

OF fundamental importance in the design of a valve gear for four cycle engines of larger bore is the use of dual valves. The beneficial effect of using pairs of small valves instead of a large single valve is of vital importance for the entire valve motion, for the valves themselves and for the cylinder head casting.

Four Cycle Valve Gear

The exhaust valves of a four cycle engine must open against a very considerable pressure still remaining in the cylinder near the end of the expansion stroke. Since this pressure amounts to something like 50 pounds per square inch, the force which it exerts on a valve of sufficient area to clear the cylinder is a large one. Because of the weight of the levers, push rods and rollers, which must be large enough to overcome the gas pressure without undue deflection, severe kinematic loads due to accelerating these parts are additionally imposed. The reaction on the cams deflects the camshaft, disturbs the delicate timing of the fuel valves and causes noticeably accentuated wear on those camshaft gear teeth meshing at the instants when the exhaust valves begin to be lifted. With the use of two valves in the place of one large one, all the affected parts become lighter and the lifts smaller; the resulting improved kinematic conditions manifest themselves in reduced cam reactions.

As regards the exhaust valves themselves, a reduction in their size is a substantial safeguard against warping with its attendant leakage and smoky combustion. Here again small size is of value, as is shown by the fact that exhaust valves of small engines do not present nearly as great problems as do those of large ones. Pitting and other deterioration of the valve seats become less and permit the use of lower grades of fuel oil.

Advantages of Four Valve Construction

The use of four valves of small diameter permits their grouping within the contour of the cylinder bore, thereby reducing the diameter of the joint between cylinder head and liner. As a consequence, the load due to gas pressures is reduced. Smaller studs can be used and the bending moment in the casting is decreased because of the smaller bolt circle. Two exhaust passages are lower in height than a single one of the same area; therefore the height of the cylinder head casting is reduced and requires shorter and hence less elastic studs to hold it down. The grouping of the valve pockets makes possible a better defined circulation of cooling water, especially if used in connection with the baffle plate mentioned before and the central cooling water circulation shown in Figs. 2 and 3. A concluding consideration of equal significance from the point of view of eliminating cracked cylinder heads is the fact that the four valve arrangement requires small holes in the cylinder heads and results in a structure better suited for resisting the mechanical and heat loads to which it is exposed.

Some designers who have appreciated the merits of the four valve construction have made the irretrievable error of placing the two exhaust valves in the same discharge passage so that the blast of the rear valve impinges upon the one in front of it. Everyone knows that an exhaust valve suffers enough from its own fire. To subject it to an additional and simultaneous blast of practically the same intensity means that the advantages of the four valve construction are thrown away and wasted. Such a practice aggravates the very evils which it is intended to cure and would not be justified even if the claim of a simple valve gear which is made for this arrangement were true.

A key to the understanding of the four valve design herewith presented is the realization that the exhaust valves have here been placed in such a way that they can be neatly provided with separate and independent exhaust passages (see Figs. 7 and 8). Each exhaust valve is operated by a double

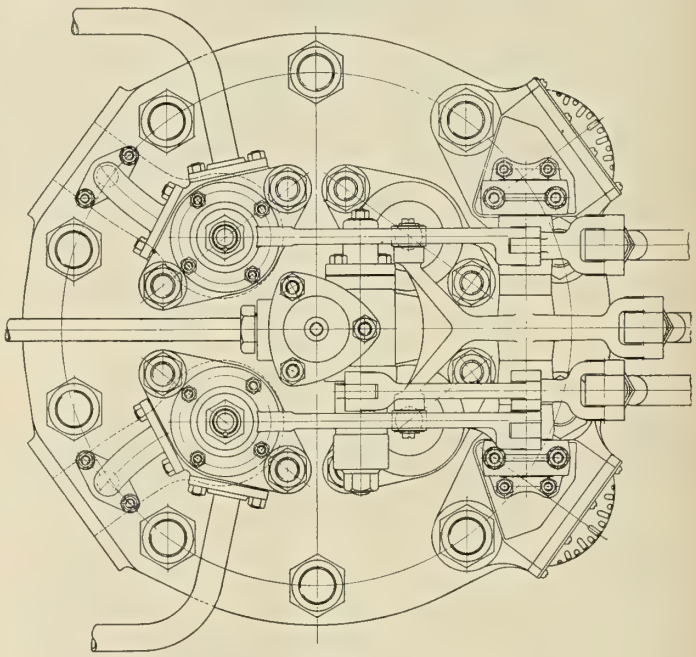


Fig. 7

cam on the end of a horizontally swinging cam rod, both of the latter receiving their reciprocating motion from one push rod through suitable levers keyed to the fulcrum shaft. The lower one of the two cam rollers is mounted on the exhaust valve spring guide, whereas the upper one has a fixed position in the valve cage which permits of slight adjustments in accordance with the clearance that is desired. This adjustment can be made while the engine is in operation.

This valve gear readily permits of access to an exhaust valve cage for removal by merely taking out the pin in the lever which operates the cam rod and withdrawing the latter. The cam rods can also be used at will to cause a slight advance in the timing of one valve with respect to the other. The severe working conditions to which an exhaust valve is subjected are thereby alleviated and further improved because of the fact that kinematic forces, instead of manifesting themselves as a single impact, are divided between two noticeably smaller force applications.

Owing to the easier working conditions of the inlet valves, a single push rod is used to actuate them through a forked rocker lever. The details of the operation and lift control of the inside spring fuel valve will be considered later. Reversal is effected in a well-known manner by swinging the ends of all the push rods from the ahead cams to the astern cams.

* Copyright, 1921, by H. R. Setz.

Since starting and maneuvering are accomplished by means independent of the working cylinders (see next section), the double roller push rod ends for exhaust and inlet need never be swung into a neutral position. Only the low fuel cam noses need be cleared, so that the shift angle through which the exhaust and inlet rollers must be traversed is merely that necessary to insure clearance between the idle roller and its cam while the other roller is operative. Conversely, also, compression relief is secured without adding a single extra part by the simple expedient of setting the double rollers in the mid-position.

While it is realized that the four valve operating linkage is somewhat more complex than the conventional two valve arrangement, the resulting advantages combined with the simplification due to the maneuvering compressor more than justify it. Considering the greater directness and fewer parts with which compression relief and reversibility are thus obtained, the arrangement must be credited with a substantial overall gain in simplicity.

Maneuvering Compressor

The starting, and for marine service also the reversing, of large Diesel engines is a problem whose solution can be neatly accomplished by using the cylinder displacement of the low stages of the injection air compressor. The requirements so far as the design of the compressor itself are concerned can be readily met and the advantages as regards simplification and improvement of the main engine are far-reaching and substantial. Complex valve gear, reversible in the case of marine engines, and the manufacture of a large number of expensive parts, whose low usage factor makes them a drag on the overhead and upkeep of the machine, are eliminated. Accessibility to the remaining gear is improved and the design of the cylinder head casting, especially in two

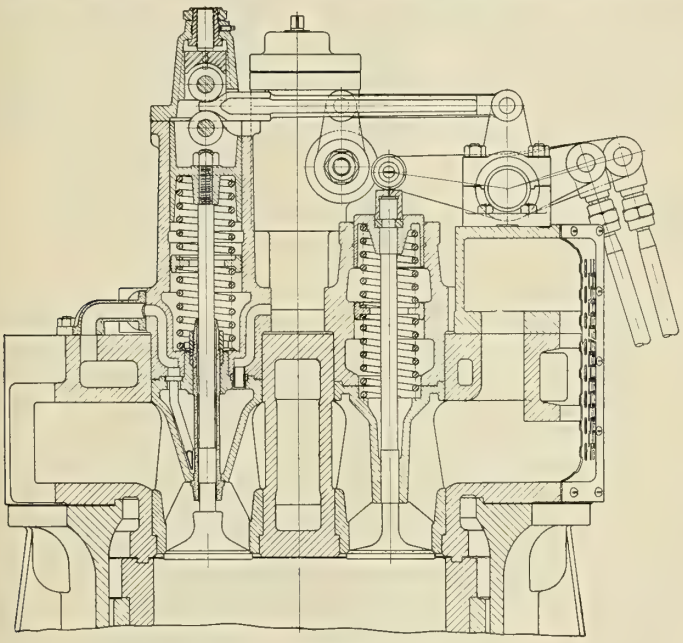


Fig. 8

cycle and double acting engines, can be better adapted to meet the severe demands to which this part is subject. An advantage of signal importance for marine engines is the elimination of alternate refrigeration and heating which occur in the cylinders of the usual types of Diesel engines while maneuvering.

Since an injection air compressor must have a displacement sufficient to charge starting air reservoirs during those intervals in which the main engine runs on fuel, its capacity is also sufficient to re-utilize the air when running as an air motor. Surely, if it is practical to re-utilize air by blowing it into the clearances of the working cylinders, its use in compressor cylinders, whose clearances are reduced to the utmost minimum, will be enough more economical to preclude any excessive requirements for compressor capacity. If it were a question solely of bringing an idle engine up to the starting speed, there would have been no need for broaching the question of power delivery from a temporarily converted injection air compressor. The severest demands upon such an arrangement that can be reasonably made are those of reversing an engine against the full headway of a ship. Owing to the lack of experimental data regarding power requirements for starting and reversing marine Diesel engines, the problem can be handled only in a general way; but the empirical knowledge which is available justifies some interesting estimates.

A Study of Propelling Characteristics

Fig. 9 shows the propeller characteristics of the United States battleship *New Mexico*. The measurements on which

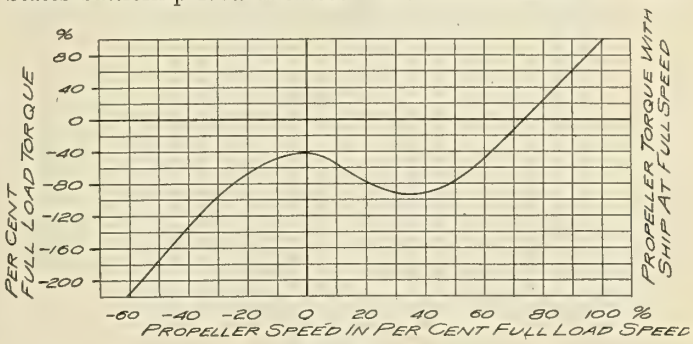


Fig. 9

it is based are electrical and were made on the driving motors of the ship. Beginning our examination at the upper right hand corner of the plot, we note that the curve passes through the point indicating 100 percent propeller speed and that naturally 100 percent mechanical torque must be supplied to it.

If the speed of the ship remains constant (this is a useful assumption of sufficient accuracy if the time interval is not too long, as in the case of reversing in a headway) and if the propeller speed is to diminish, less torque is required to keep it running at the reduced speed. To keep the propeller turning, say, at 90 percent of full speed would require the application of 60 percent full torque, the ship's speed remaining constant for the time being. When the torque falls to zero, as is very nearly the case when the propelling motor is deprived of all excitation, the propeller continues to revolve at 73 percent full speed.

Descending the curve below the line of zero torque, we find that a negative torque or braking moment must be applied to the propeller in order to make it revolve at a speed lower than the one at which it will idle along. Like any water wheel (as such a passive propeller may be regarded) it has a definite speed at which the water flowing past it will exert upon it the maximum turning effort. In the case of the blading here considered the speed of maximum torque is reached at 35 percent of the full driving speed. Naturally the maximum active torque of the propeller has nothing to do with the negative maximum here considered because it stands to reason that the maximum motor torque required by a propeller must be supplied at a speed exceeding its pitch speed and that, like a water wheel, it will be subjected to a maximum water torque at a speed below that corresponding to its pitch. Hence, as we follow the curve still further to the left we find that less braking torque need be applied at the lower propeller speeds in spite of the increasing water velocity relative to the blades moving at a speed which deviates increasingly from the speed of maximum water torque.

Here is a fact of high importance from the standpoint of

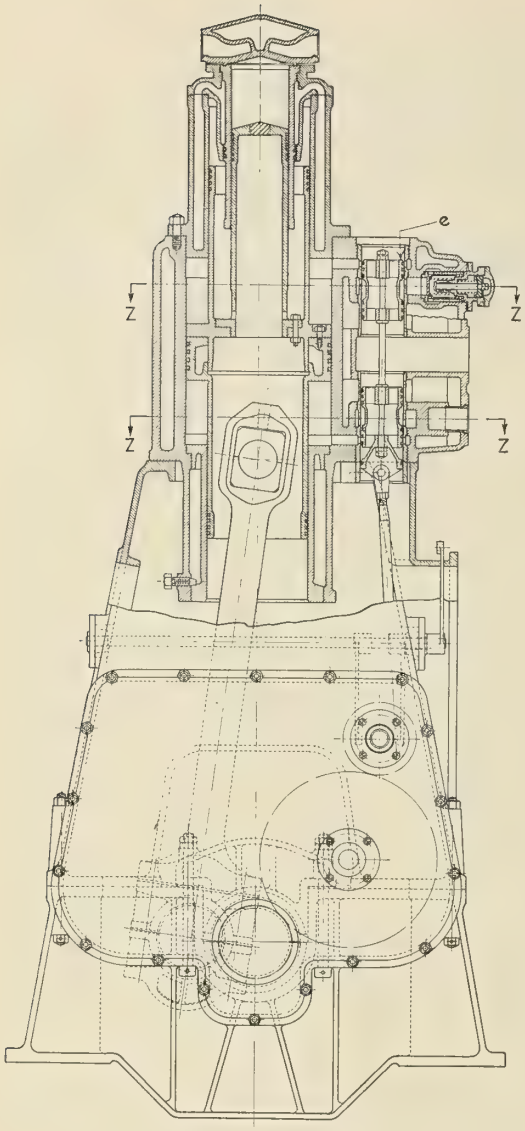


Fig. 10

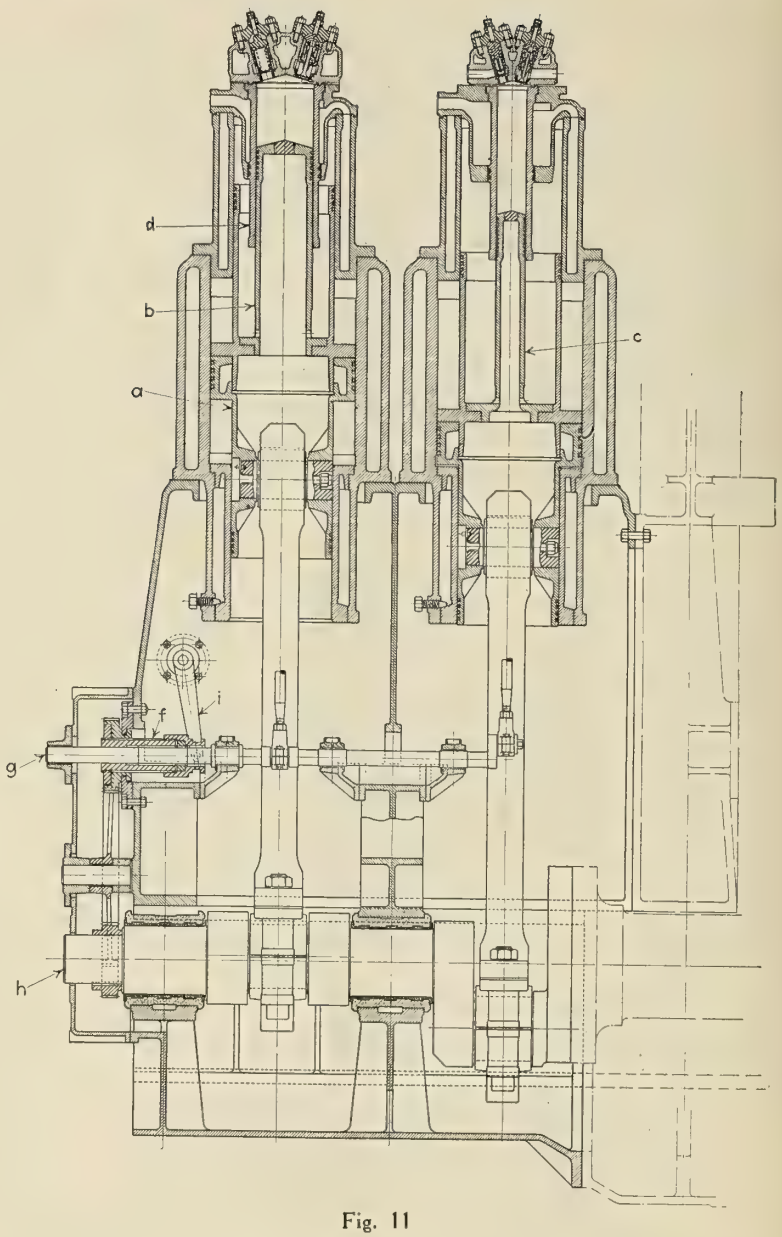


Fig. 11

maneuvering compressor design. Once it has been possible to supply a braking torque of about 94 percent (under the conditions represented by the curve) the propeller must come to rest because the more slowly it moves after being retarded thus far the less torque is required to retard it further. The curve crosses the line of zero propeller speed at minus 42 percent, showing that it takes less than half the full power torque to start the engine astern. If 100 percent torque capacity is provided, there will remain an ample margin for accelerating the engine in an astern direction up to the speed where ignitions in the working cylinders can occur. Under actual conditions of an immediate reversal the ship will have lost momentum, the rush of water past the propeller will be less and its torque resisting reversal will be less than that indicated by the figures.

Description of Compressor

A compressor in the design of which these considerations have been taken into account is shown in Figs. 10, 11 and 12. It is dimensioned for an 800 brake horsepower engine running at 140 revolutions per minute and having a gross working cylinder displacement of 36.7 cubic feet per revolution. This engine exerts a full load shaft torque of 30,000 foot pounds.

The twin cylinder compressor is chosen primarily to insure safe starting in all crank positions when running as an air motor. The throws are naturally spaced 90 degrees apart. The double acting, low pressure pistons *a* can also be proportioned in a manner which, in combination with the smaller pistons *b* and *c*, yields the proper volume ratios for four-

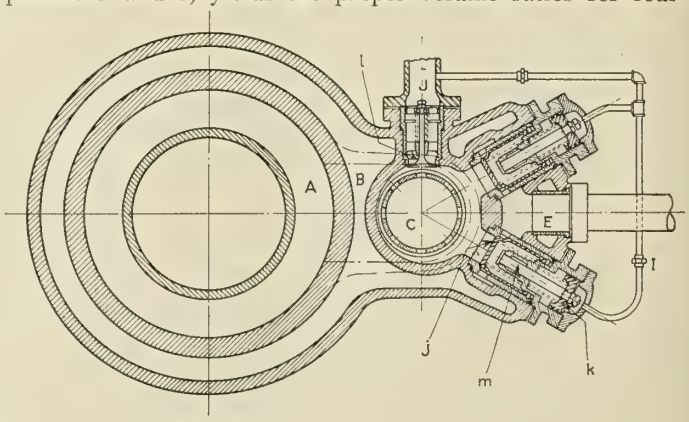


Fig. 12

stage compression. The upper large cylinder ends of both compressors and the lower end of the right hand one all deliver air into the same intercooler. The remaining one of the four large cylinder ends draws air out of this intercooler and,

after subjecting it to first intermediate compression, delivers it to the intercooler leading to the second intermediate cylinder *d*. The piston extensions or trunks are provided in order to accommodate the upper connecting rod bearings. The net area of the low pressure pistons, after deducting that part which is taken up by the piston trunks, amounts to 131.8 square inches each and the common stroke is 16 inches.

As has been stated, three of the low pressure cylinder ends draw in fresh air for compression into the remaining one.

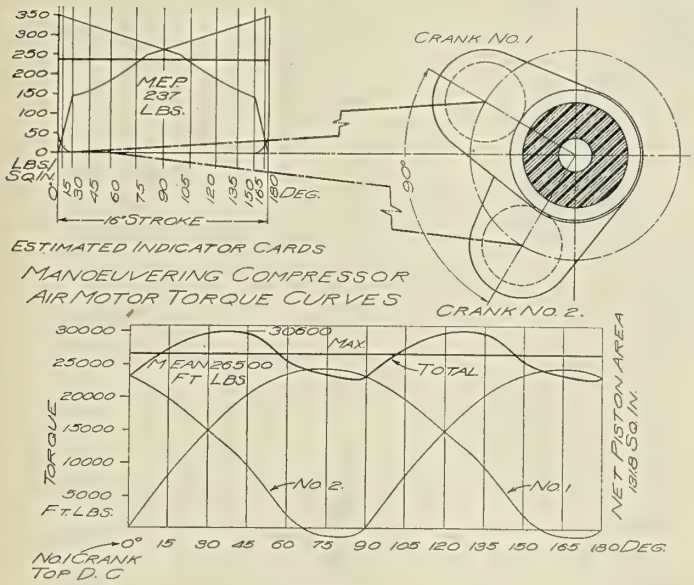


Fig. 13

The cubical displacement of these three ends is 3.67 cubic feet, or .20 of the 18.35 cubic feet of the effective working cylinder displacement. For large modern engines fitted with fuel valve lift and timing control to suit load and speed variations, the accepted proportioning of compressor capacities may be expressed as follows:

$$C = RW$$

C = cubical displacement of compressor.
W = cubical displacement of working cylinders.
R = a constant.

For four cycle engines $\frac{W}{2}$ must be used instead of W.

A range of values for R frequently found on heavy duty four cycle engines is from .18 to .2.

When running as an air motor provision is made for supplying all four cylinder ends with starting air at 350 pounds per square inch, at which pressure they develop the torque shown in Fig. 13. The percentages of cut-off shown on the estimated indicator diagrams are a minimum for the valve gear used and a pressure drop due to throttling during admission equivalent to 100 pounds per square inch is assumed. Since frictional resistance within the mechanism is a highly indeterminate quantity, no allowance has been made for it. An ample margin is afforded by the possibility of varying the starting air pressure to counteract any errors due to estimating friction or to other causes. The minimum indicated torque shown in the diagram amounts to 23,500 foot pounds, or 70 percent of the main engine torque. Forty-two percent, we have seen, is the maximum that could possibly be required to start the engine backwards while the ship is under full headway. The curve shows a maximum of 30,600 foot pounds, a torque slightly exceeding that of the main engine under full power. Only 94 percent is required to bring the engine to a standstill under the most unfavorable assumptions.

The advantages of eliminating the high starting air pressures usually employed need hardly be emphasized. Ordinary riveted starting air reservoirs can be used and no special tubing, fittings and joints are necessary for connecting them to the engine.

Valves and Valve Gear of Compressor

The valves and gear by means of which the maneuvering compressor is controlled are simple and require no cumbersome expedients for effecting reversal or for converting the machine from a compressor to a motor or vice-versa. Referring to Figs. 10 and 11, it will be seen that the essential elements of the valve motion comprise piston valves *e* and a geared drive whose angular phase relative to the main shaft can be shifted by means of helix *f*. In the arrangement shown, the well-known fact that a compressor with mechanically driven valves will run reversed as an air motor when supplied with compressed air is taken advantage of. All that is necessary to make the machine run in the same direction which it had when compressing air is to reverse the angular phase of its valve drive. To make it run in the opposite direction it is required merely to connect the air reservoirs without shifting the control. The ahead or astern lead of valve

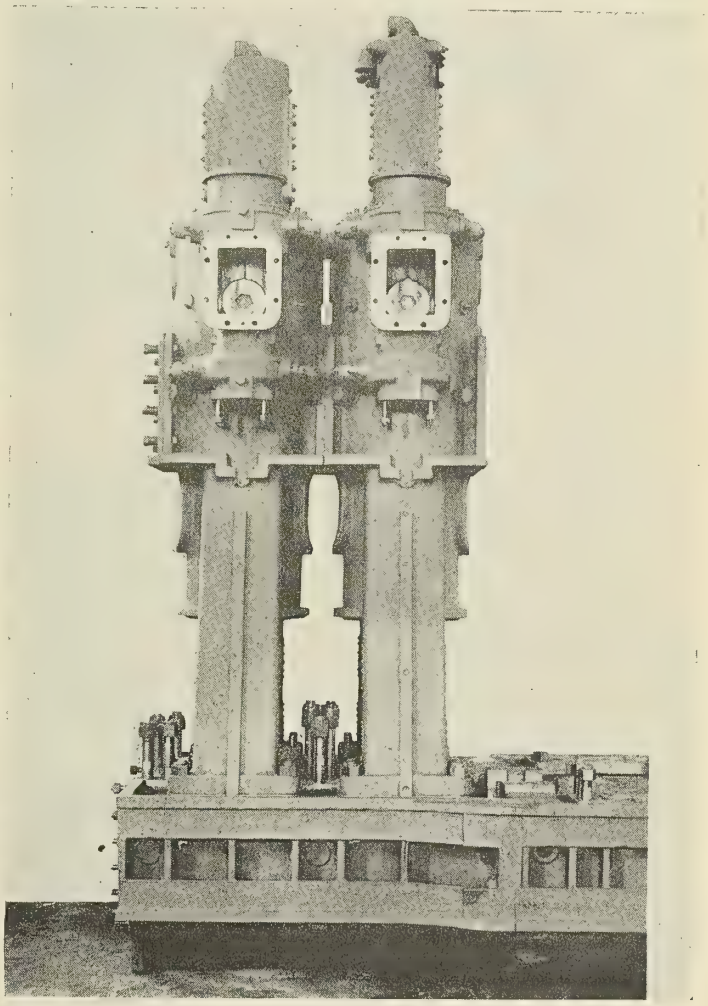


Fig. 14.—Compressor and Starting Engine, 550 Horsepower M. D. E.

cranks *g* relative to main cranks *h* is determined by means of helix *f* and lever *i*.

To eliminate the effect of too long a delivery (cut-off) inherent in piston or slide valve control of compressors, auxiliary discharge valves *j* (Fig. 12) are provided. These prevent the cylinder from discharging until its contents have attained the proper pressure. For motor operation, the auxiliary discharge valve *j* is held upon its seat by means of balance piston *k*, actuated automatically by starting air entering through

pipes *I* communicating with starting line *J*. The check valve *l* reduces cylinder clearance. Air is exhausted through the same mufflers which served as silencers for the suction of the compressor. In the case of the first intermediate stage cylinder end a positive transfer valve switches its suction (which has now become an exhaust) from the first intermediate intercooler to the atmosphere. The starting air pipe *J* is vented as soon as starting air is turned off, a provision which insures positive seating of valve *l* and the return of stops *m* during compressor operation.

Since the process of converting the compressor into an air motor and turning on starting air can be accomplished by hand operating a single lever, the simplicity of this maneuvering system compares most favorably with those found on other installations. With the exception of the high and second intermediate pressure ends respectively, both main cylinders with their pistons, valves and connecting rods are alike and interchangeable in every detail and of a size which makes them a relatively small part of the engine proper.

Fig. 14 shows a maneuvering compressor as built by a prominent firm engaged in Diesel engine manufacture. It is installed and operated on a number of ships fitted with engines of their make.

The Two Cycle Engine

The two cycle engine has had a much more desultory development than the four cycle, and at the time when the main impulses to bring out this type of engine occurred less than ten years ago large units were undertaken without anything like the gradual preparation which preceded four cycle constructions. Many particular problems inherent in and peculiar to the two cycle machine were not properly considered or even understood and the practical accomplishments of over-enthusiastic and ill-conceived attempts could be none else than disappointing. The severity of the conditions under which early two cycle experiences were gained was aggravated because installations of large units were made on ships and presented operating difficulties far more trying than the heaviest central station requirements.

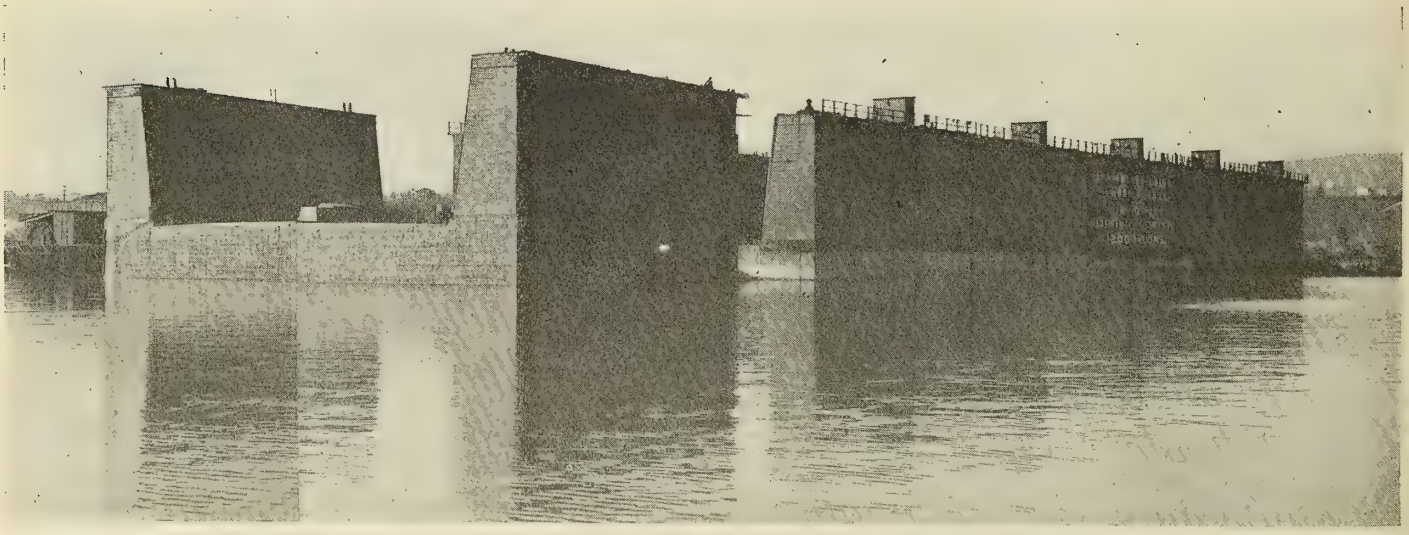
The years that have elapsed since then have given an opportunity to devote the same systematic study to the essential requirements of satisfactory two cycle Diesel engine construction. Experimental information has been secured, with the result that the more recent development for applications of the two cycle type bids fair to exceed in short time the progress which has been made in the four cycle engine field. At the present time two cycle installations aggregate approximately 750,000 horsepower. The fact that this output is realized in comparatively few units shows unmistakably that the field for large Diesel engine units is pre-eminently one for two cycle application.

The reasons for this are not far to seek. Approximately twice the output of the four cycle engine is attained for the same piston speed, or, conversely, for the same horsepower output the bore of the cylinders may be materially reduced, a procedure which more than offsets the greater frequency of the heat impulses sustained in the two cycle engine. The objections on the score of heating have lost much of their force because it is possible to design cylinder heads, the most vulnerable parts of a Diesel engine, with a scientific and positive water circulation that minimizes such troubles. Finally, the difficulties ascribed to non-reversing bearing pressures occurring in the single acting, two cycle engines have been deprived of their seriousness because of other materially improved bearing conditions. A crank shaft with short and thick pins and journals, ample areas and a frame construction which protects bearings against deflections, are features which outweigh a none too well established theory of pressure reversals.

Scavenging air can be supplied from a source independent of the engine, preferably from an electrically driven turbo compressor. The high degree of perfection and reliability which have been attained in these simple machines recommends them emphatically for substitution in place of the lumbering piston pumps. On shipboard they afford a notable economy because they can be operated with current from auxiliary engines which would otherwise be used only while in port and would therefore be a drag on the installation because of their low usage factor. An even greater advantage of auxiliary driven scavenging air supply on ships is that its pressure is maintained during maneuvering and slow running of the main engines. Hence in all the two cycle work here considered direct driven scavenging pumps and their attendant features will be conspicuously absent.

(*To be continued.*)

LARGEST FLOATING DRY DOCK IN SOUTH PACIFIC WATERS



By Far the Largest Floating Dry Dock in South Pacific Waters is That of the Los Angeles Shipbuilding & Dry Dock Company, Los Angeles, Cal. It Measures 540 Feet With 84 Feet Beam and Will Raise Vessels Up to 12,000 Tons

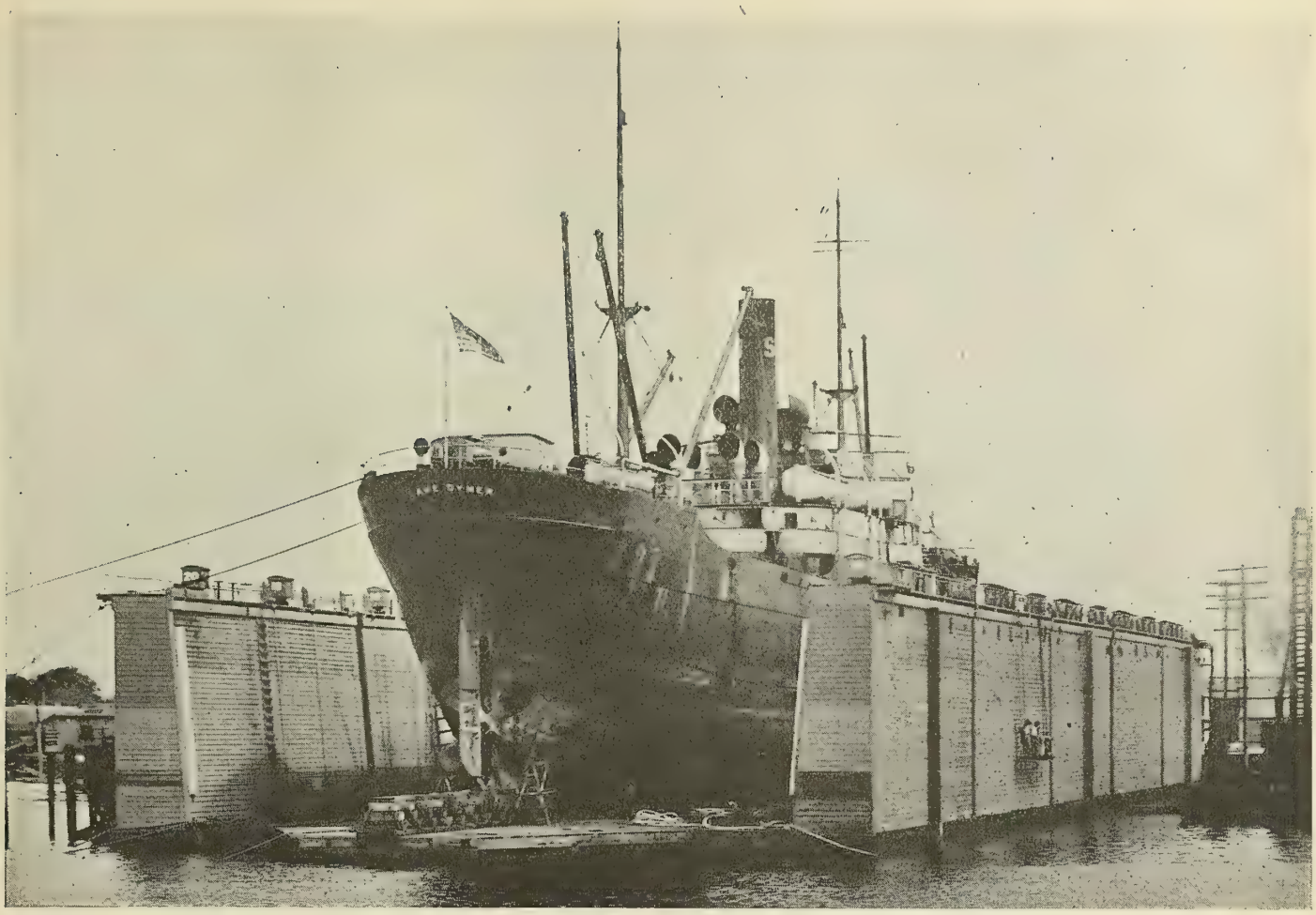


Fig. 1.—*Lake Dymer*, First Ship on New Floating Dock

New Floating Dry Dock at Pensacola

Longitudinally Trussed Timber Dock of 6,000-Tons Lifting Capacity—Details of Construction and Pumping Arrangement

APPRECIATING the growing importance of the Gulf ports in the world shipping trade and realizing the necessity for increased dry docking facilities at Pensacola the Bruce Dry Dock Company was formed during the fall of 1917. The company acquired the sixty-year old 1,000-ton floating dock built before the Civil War by Bruce and Ollinger, put it in operation and then immediately began to make investigations with a view to getting a larger floating dock, and increasing their repair plant.

After studying the various types of floating docks the company engaged The Crandall Engineering Company, East Boston, Mass., to design a 6,000-ton capacity timber dock of the longitudinally-trussed type. Construction was actually begun in August, 1919, by Aberthaw Construction Company and the first pontoon was launched the middle of December of the same year and a pontoon launched monthly until April when the last pontoon slid into the water. By the middle of June the fitting up was completed, the five sections were joined together and the electric wiring installed ready for operation.

The first vessel dry docked was the *Lake Dymer* which was raised in about 30 minutes from the time the pumping commenced, everything running smoothly. The pumping was controlled from the headhouse on the wharf and the success and ease of this method of centralized control demonstrated the wisdom of the design.

The general dimensions of this dry dock are 380 feet over the keel blocks, 74 feet between the wings and 18 feet of water over the blocks. It is made up of five pontoons each 62 feet long.

Longitudinal Trusses

In each wing wall of the pontoons is incorporated the panel of a longitudinal truss. These trusses are built up of timber compression members and steel tension members which terminate in steel castings at the panel points, which castings are furnished with lugs for joining the sections together, as illustrated in Fig. 2. When the sections are joined these truss panels are formed into one longitudinal truss along each wing of the dock. These trusses make the dock operate as a unit instead of as a number of loose sections and thereby equalize any unequal buoyancy of the sections due to irregularity of pumping, safeguarding any vessel dry docked from severe stress and distortion due to this cause.

Transverse Trusses

The type of transverse truss frequently used in wooden floating docks has certain inherent faults of design and construction and is subject to extreme deflection. For the transverse truss, therefore, a type was developed which would approach as nearly as possible a perfect truss for this work, namely one that would have minimum deflection, minimum cost and maximum strength. Fig. 2 shows the type developed,

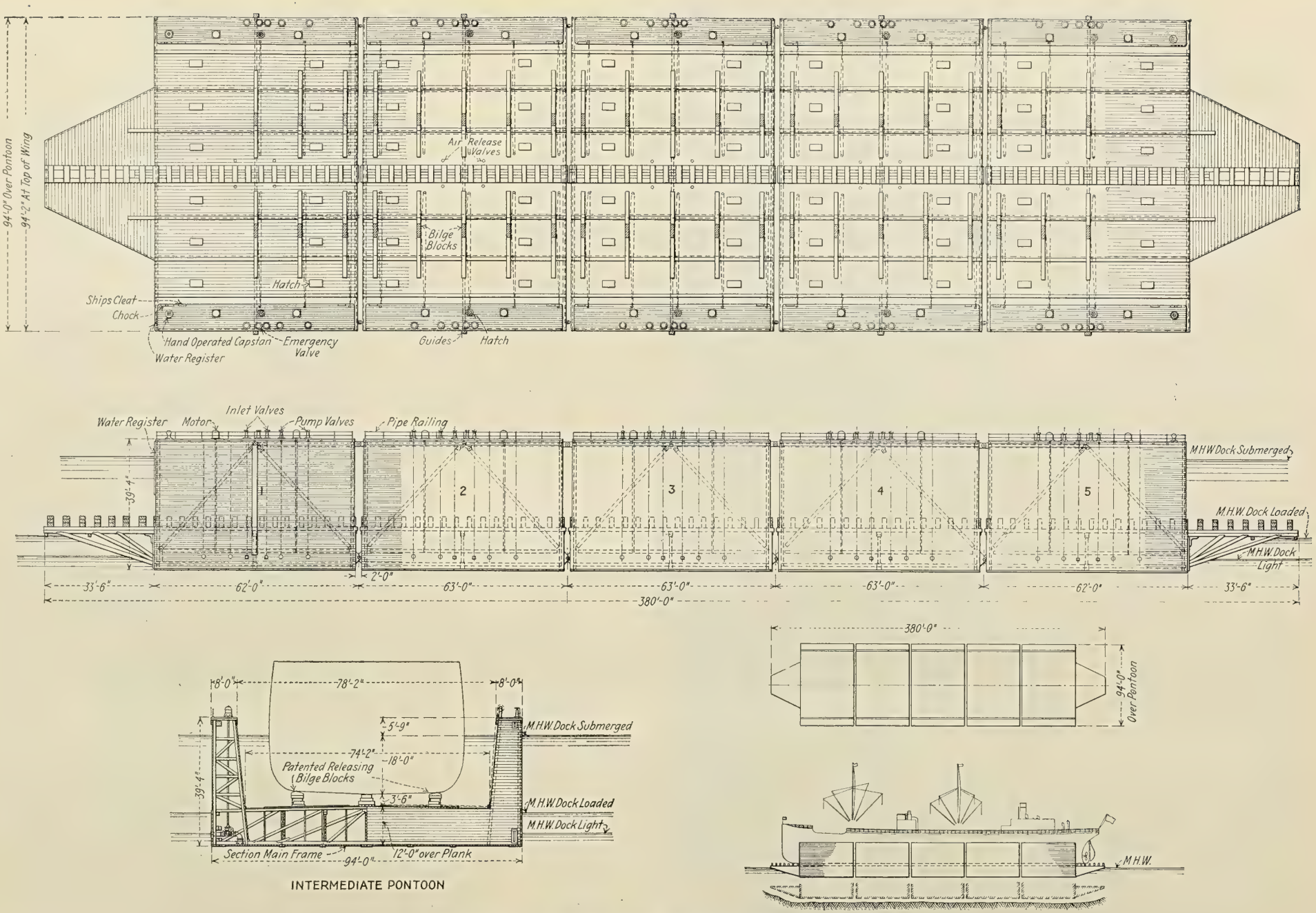


Fig. 2.—Plan, Elevation and Sections of New Pensacola 6,000-Ton Floating Dry Dock

the problem being a statically determinate one in which the stresses can be accurately determined and the sizes of timber properly proportioned with proper factors of safety for the stresses involved and the economy and rigidity of this type have been amply proved by this and other docks of similar design.

Pumping Arrangement

The pumping is done by means of twenty 10-inch centrifugal pumps, four in each pontoon, each of which is direct connected to 20 horsepower motors. The control of these motors is centralized in a control house on the wharf structure where the dockmaster can see the indicators showing the height of water in each compartment and govern the pumping accordingly. A full capacity vessel can be lifted clear of the water ready for repairs in less than forty minutes.

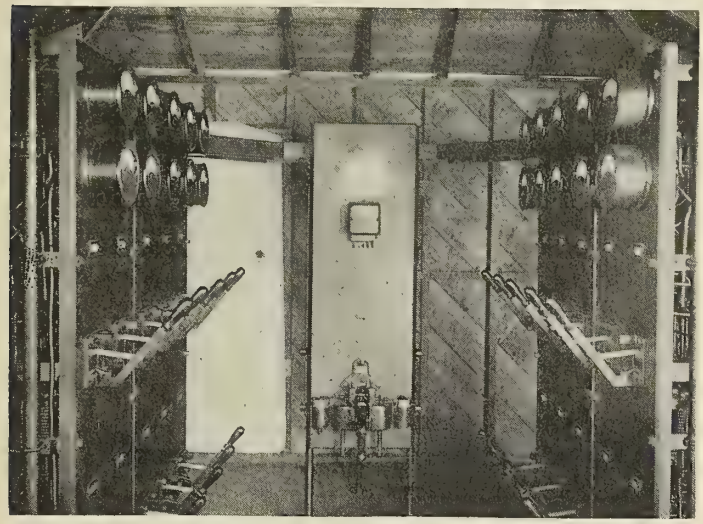


Fig. 3.—Control Board Showing How Control is Centralized

Absence of Ballast

Although an all timber dock, no rock ballast is used to sink it to full draft. Instead a very simple water ballast system is used. By this means the full lifting capacity of the dock is available to raise a vessel instead of from 20 to 25 percent being required to raise rock or other ballast, and thus unavailable and wasted.

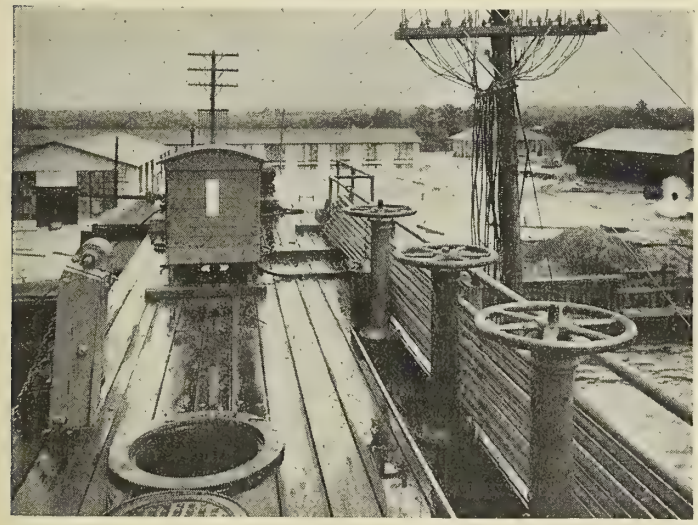


Fig. 4.—Wing Deck View, Looking Inboard. Motorbox, Valve Operating Stands and Bilge Block Operating Winch

Entering into the cost of this dry dock are 1,300,000 feet of yellow pine lumber and 15 tons of steel castings. The motors were furnished by the Wagner Electric Company, St. Louis, Mo.; the pumps by the F. H. Hayes Machinery Company, Boston, Mass., and the switchboard apparatus by the Condit Electrical Manufacturing Company, Boston, Mass.

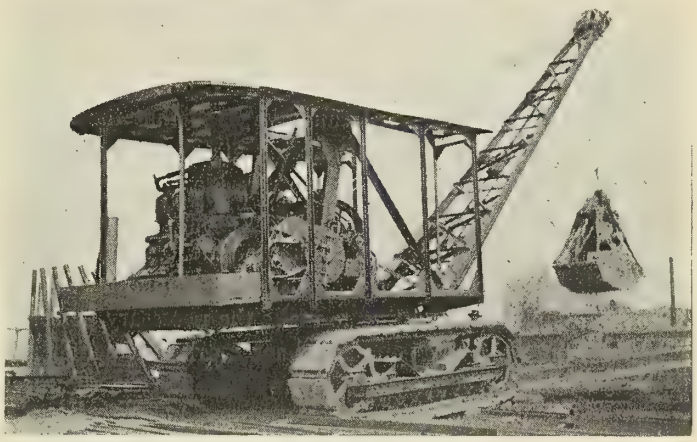
The dock was constructed by the Aberthaw Construction Company, Boston, Mass., and supervised by Paul H. MacNeil, field engineer for the designers, the Crandall Engineering Company, East Boston, Mass.

Northwest Crawler Crane

One of the latest products of the Northwest Engineering Works, Chicago, Ill., is the Northwest crawler crane. Traveling under its own power on two manganese crawler type wheels, the crane is built to go anywhere, any time, like the war tanks, and is steered as easily as a truck with the boom in any position. It is equipped with self-alining ball bearings or bronze bushings with no babbitt boxes, and 41 percent of the weight of the complete crane consists of manganese or carbon steel castings.

The machines are built on full revolving, rotating bases equipped with extra heavy 4-cylinder, 60-horsepower gasoline engines and will operate a one cubic yard clam shell or three-quarter cubic yard drag line bucket, pile driver hammer, wood grapple or electric lift magnet.

The lifting capacities range from 20,000 pounds at a 12-foot radius to 5,200 pounds at a 30-foot radius. A single lever in the operator's cab manipulates the steering device so arranged that both crawlers are driven at the same speed straight ahead or with different speeds for steering positively in any direction required. The machine will mount a coal or stone pile as easily as it travels along a good highway and is especially adapted for unloading cars or barges.



Crawler Crane Operating a Grab Bucket

R. C. Rimmer of 149 Broadway, New York City, naval architect and consulting engineer, has been appointed assistant sales manager for these cranes.

The Superheater Company

Soon after taking over the patents and business of the Locomotive Feed Water Heater Company, the Locomotive Superheater Company, New York, changed its name to The Superheater Company.

Together with its production of superheaters for all manner of steam power generators, the organization has also become actively engaged in the intensive development of feed water heating equipment for locomotive and marine application. The Superheater Company wishes to renew its assurance of service to all companies with whom it has been able to co-operate in the past and also to offer the facilities of its organization to any company having problems in fuel conservation to solve.

Marine Engineering

Published Monthly by

ALDRICH PUBLISHING COMPANY

In Conjunction With

SIMMONS-BOARDMAN PUBLISHING COMPANY

6 East 39th Street and Woolworth Building, New York

F. B. WEBSTER, Editor
H. H. BROWN, Managing Editor

S. M. Phillips, Associate Editor
A. J. Kaufmann, Associate Editor
L. S. Blodgett, Associate Editor
W. Z. Gardner, News Editor

Contributing Editors

Rear Admiral C. W. Dyson, U. S. N.
Commander S. M. Robinson, U. S. N.
Professor C. H. Peabody
Captain C. A. McAllister, U.S.C.G. (Retired)
William Gatewood
H. McL. Harding
William T. Donnelly
James L. Bates

WE GUARANTEE, that of this issue 6,800 copies were printed; that of these 6,800 copies 5,448 were mailed to regular paid subscribers, 360 were provided for counter and news company sales, 266 were mailed to advertisers, 85 were mailed to employees and correspondents and 641 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 32,600, an average of 8,150 copies a month.

Marine Engineering is a member of the Associated Business Papers, Inc. (A. B. P.), National Association of Periodical Publishers, Inc., New York Business Publishers Association and the Audit Bureau of Circulations (A. B. C.).

Immediate Action Demanded

THE failure of the new administration to nominate a new Shipping Board in time for confirmation by the Senate before its adjournment was most unfortunate and it is to be hoped that this matter will receive the earliest consideration that the President can give it so that the Senate may act immediately upon assembling at the special session this month. It is evident that the President feels that the position of chairman of the Shipping Board requires the services of one of the biggest men that the country affords and, while we appreciate the difficulty in securing the services of such a man who is willing to make the necessary personal sacrifices, the welfare of our merchant marine demands immediate action if we are to derive any benefit from the most gigantic shipbuilding effort ever attempted by any country.

Admiral Benson

ALTHOUGH the status of Admiral Benson's position on the Shipping Board is, at the time of this writing, somewhat uncertain, it cannot be said that the Admiral has not made his position plain on those policies which he thinks will be for the best interests of our merchant marine and there are very few if any of those who criticize these policies who doubt that in his straightforward pleas for the maintenance of the merchant marine he is guided by the most sincere and patriotic convictions. It ought to be evident to everyone as well as to the Admiral that the time for debate, investigating committees and destructive acrimonious criticism is past and that now is the time for us to take off our coats, lay out a straight line of action and work to it.

The Admiral is anxious to be put on record as heartily in favor of the Merchant Marine Act of 1920 and he is opposed to any movement that purposes to take the teeth out of this law until it has had a fair trial. The preferential rail export rates which this law provides for American vessels and the provisions for discriminatory custom duties and tonnage dues should be put into full force, says the Admiral, and in this connection it should be noted that these preferentials are designed to help shipbuilding as well as shipping. Shipbuilding, on which the American wage standards protected by a tariff on manufactured and agricultural products exert a vital influence, cannot flourish while other industries are not only protected but charge the shipbuilders appreciably higher prices for most of the equipment that goes into a ship and shipyard on account of this protection.

Whether Admiral Benson's views are adopted as the future policy of the new Shipping Board or not he has performed a distinct service in outlining a definite and comprehensive line of action. He has considered the welfare of shipbuilding as well as shipping, the vital necessity for an American built and manned merchant marine as a naval auxiliary and he believes that the best way to accomplish this is to put into full force all the provisions of the Merchant Marine Act.

Our Foreign Trade

THE solution of our foreign trade problems has become vitally imperative and it not only affects the future success of our merchant marine but the prosperity of the whole country and particularly the great agricultural and manufacturing interests of the Middle West. We have an enormous surplus supply of grain consisting of several hundred millions of bushels above the country's normal needs. We have vast supplies of raw materials, for example, millions of bales of cotton, standard articles of manufacture and manufactured specialties which must be sold outside of this country, if the 4,000,000 and over pairs of hands that are now idle are to be given a chance to work and in turn purchase their share of goods. Fortunately the demand for our products exists and foreign buyers need American goods more than ever but credit, the foundation of all business, is almost hopelessly blocked by the great trade balance that has piled up in our favor as a result of the war.

Since the armistice we have received vast purchasing orders that would normally have been extended over a period of years in which case they could easily have been financed by the absorption of securities as practiced by England and other creditor nations. The result of this one-sided export business is that our commercial banks have reached the limit of their ability to extend credit, that the American dollar is at such a high premium in most foreign countries that it has become impossible for foreign buyers to do business with us except on the basis of long term loans and that we have taken all the gold that foreign countries can spare. Other countries still have excellent securities such as large stores of sugar, oil, mortgages, government bonds, etc., and several of our large corporations, including the United States Steel Corporation and the Bethlehem Steel Company, are helping the situation all they can by financing their foreign customers on a long term basis.

Independent financing, however, can only take care of a small percentage of our exports. More gold is neither attainable nor desirable, bartering is crude, subject to great risks and at best only an emergency measure, and most of all we cannot afford to take our pay in billions of dollars' worth

of manufactured products dumped into this country, when we can produce more than we need ourselves. It, therefore, remains for institutions like the Foreign Trade Financing Corporation and similar companies authorized by the Edge amendment to the Federal Reserve Act to finance their long term loans by issuing debenture bonds to the value of ten times their original capital. The $100,000,000 Foreign Trade Finance Corporation alone would thus be able to use $1,100,000,000, for the purpose of supporting the credit facilites of our foreign trade and by so doing provide work for the unemployed in this and other countries, insure us a steady market through its financial interest in foreign enterprises and return to us good interest on the money invested.

Millions of dollars' worth of export business is being lost through our present inability to finance our foreign trade on a long term basis and the manufacturers of one Middle Western state are losing $20,000,000 in orders from southeastern Europe alone. Purchasing agents for foreign buyers are here in greater numbers than at any time since the war, seeking credits for responsible firms in European countries, Japan, South Africa, South America and Australia for the purpose of buying our products. The great question is whether our country will back up our export business with the same concerted support that Great Britain has given to foreign trade not so much for the purpose of helping other nations, our merchant marine or special interests as to enable our great industries to return to a full time schedule with plenty of work for everyone.

Seaman's Act Handicaps Passenger Ships on the Great Lakes

THE difference between the summer and winter lifeboat accommodations required by the Seaman's Act for passenger vessels on the Great Lakes is so large that the profitable passenger navigation season is practically limited to the four months commencing May 15 and ending September 15. The steamboat men assert that the records of weather conditions of the Department of Agriculture show that this season may be safely extended six weeks to run from May 1 to October 15.

The number of lifeboats and rafts that a ship can carry depends largely upon the design of the vessel and Great Lakes steamers which are limited to comparatively small drafts, on account of the ports that they enter, cannot carry too much top hamper. While each vessel must be figured separately, the case of the passenger ship *See and Bee* which runs on the Cleveland-Buffalo route illustrates the great reduction in the number of passengers that she can carry between May 1 and May 15, and also between September 15 and October 15.

The *See and Bee* is equipped with fourteen 30-passenger lifeboats, two 20-passenger lifeboats and two 16-passenger lifeboats accommodating a total of 492 persons. Outside of the summer season, the law specifies that a sufficient number of lifeboats and rafts must be carried to accommodate every person on board and that 75 percent of this number must be taken care of by boats. The ship can then carry 164 more persons by providing the necessary rafts, which brings the total sum to 656, but in order to man the ship a crew of 161 is necessary, which reduces the number of passengers to 495. In the summer season, however, the law specifies that accommodations for only 50 percent of the persons on board in lifeboats and rafts need be provided and of this number but 40 percent need be cared for by lifeboats. Thus her lifeboats take care of 492 persons as in the winter but she may provide raftage for 738 additional as compared with 164 in the winter. She thus provides rafts and boats for 1,230 persons; but as it is only necessary to carry this equipment for 50 percent of the people on board in the summer, she may take on a total of 2,460 persons. The size of the crew in the summer is increased to 186, which allows a total number of 2,274 passengers that may be carried between May 15 and September 15 as compared with 495 immediately before or after that period.

It is evident that no allowable reduction in crew or operating expenses can offset such a great reduction in passenger carrying capacity and there appears to be no apparent reason why the act should not be amended so as to include in the summer season the desired six weeks' extension as the law in its present shape has been a source of hardship and loss to Great Lakes operators for the last six years.

Shipbuilders' Claims

NOT the least of the many difficulties with which the Shipping Board has to contend, is the settlement of the huge claims held by the shipbuilding and shipping interests against the Government. The status and details of these claims are fully discussed in an article appearing on page 298 of this issue, which explains the vast amount of work and the procedure that must be taken before these obligations can be amortized.

The total amount of these claims now on record amounts to $147,000,000, but there are still many others that have not been filed, which, together with the payments coming due for work that will be completed during the next year, will amount to many more millions. On the other hand, the amount of money that actually will be paid in these settlements will, probably, be scaled down through compromises and adjustments to a much lower figure than the total of the amounts claimed.

While we appreciate the difficulties that the Shipping Board must overcome in checking over the details of the almost numberless items in these claims before it can conscientiously make an award and the natural tendency of Congress to go slow in appropriating the necessary money, it seems too bad that the shipbuilders, including many of our best established yards, should have to wait for their money until their resources are so strained as to endanger their very existence.

There can be no doubt that the American people as well as Congress are convinced that an American merchant marine is absolutely necessary for our safety and prosperity, but it does seem as though every possible obstacle that can be placed in the way of our shipbuilders from the neglect to enforce the prospective protective measures of the Merchant Marine Act down to the decision that those who want to take a drink

on the ocean, which, curiously enough, includes many who are ardent prohibitionists at home, must take passage on a vessel flying a foreign flag. As Admiral Benson recently stated, if we want a merchant marine we must "aim steadily at it," but how are we to do this if the government makes laws which are not enforced and refuses to pay promptly its just debts to those interests that have had the courage to attempt to place the American flag on the high seas?

A New Transatlantic Service

According to one of our English contemporaries "One of the most interesting developments this spring will be the inauguration of the new transatlantic service of the Royal Mail Steam Packet Company between Hamburg, Southampton, Cherbourg and New York." Marine Engineering has repeatedly pointed out the need for new passenger vessels flying the American flag and this new venture is only one more proof of the fact that foreign nations are perfectly willing to handle the passenger and fast freight trade across the Atlantic if we lack the facilities to do our share of the business. In addition to this, it is reported that the Royal Mail Company is figuring on establishing a new passenger service between the west coast of the United States and Europe, where there should be a particularly good field for bringing over immigrants and taking back food and fruit in refrigerated cargo spaces. The vessels scheduled for the Hamburg, Southampton, New York route are the *Orbita, Oropesa* and *Orduna* and the service is already advertised to commence May 2, with semi-monthly sailings thereafter. The *Oropesa* was launched at the yard of Cammell Laird & Company, Limited, Birkenhead, England, last December and she is a twin screw passenger and cargo vessel of the intermediate type, 552 feet in length, having a gross tonnage of 14,500 tons. There is no question of our ability to build this type of vessel, as we are now constructing a number of practically the same size, and it is to be hoped that the new administration will shortly fix on a definite shipping policy that will be liberal enough to inject some enthusiasm into the shipping interests in the matter of passenger ships.

Motorships

America leads the world in the percentage of ships in which the power is obtained from oil fuel, but in practically every case the oil is burned under boilers to generate steam instead of inside the cylinders of internal combustion engines. If our merchant fleet had been built under normal conditions instead of under the necessity of getting into the water in the shortest time possible the largest number of vessels that would be certain to operate smoothly, and for which qualified engineers were known to exist, it is more than probable that we would have had our share of motorships.

The world's supply of fuel oil is very limited, so much so that the Navy Department is very much concerned in securing and conserving adequate oil reserves for war vessels. The probability is that the cost of fuel oil will increase, if not in price then relatively through decreases in the cost of coal. As a general rule it may be stated in regard to oil or coal fired boilers that when twice the number of cents a gallon of fuel oil costs is greater than the number of dollars per ton of coal, it is more economical to burn coal.

The amount of oil used in motorships, however, is only about 40 percent per shaft horsepower of that used in oil-burning steam installations and, aside from the fact that we ought to use our natural resources in the most economical manner, it is evident that motorships can run long after the price of oil for burning under boilers becomes prohibitive.

Mr. Frank Munson, president of the Munson Steamship Company, has advocated changing some of our Shipping Board vessels to motorships and there is no better time than the present when so many vessels are tied up to do this; but, unfortunately, Congress is not in the mood to appropriate money for shipbuilding. Several vessels are being converted to the electric drive method of propulsion and those that are finished are giving a good account of themselves. While Europe is going ahead with a large motorship programme we are allowing our country to get further and further behind in the construction of a type of vessel, the lack of which will make it harder for us to compete with the merchant marines of other countries.

Engineers for Political Positions

The American Engineering Council of the Federated Engineering Societies in requesting President Harding to appoint an engineer as Assistant Secretary of War, and also to name an engineer for a vacancy on the Interstate Commerce Commission, was not seeking to further the interests of an individual group of men but rather suggesting a means of improving the administrative departments of the Government. Although lawyers have held a practical monopoly of political jobs, there are many positions that require very special qualifications, a large part of which are concerned with engineering.

The Navy, the Shipping Board and the Interstate Commerce Commission all employ a large number of men of engineering training and experience. The nature of the work handled by these departments is such that the preliminary exploration, construction, final survey, upkeep and operation require the services and knowledge of the engineer. Not only is this true of technical physical matters, but also in determinations of policy the judgment of the engineer should be more comprehensive and valuable than that of men of other professions.

The engineer as an executive would bring to investigations and deliberations a judicial mind trained to observe the inexorable laws of nature which are involved in the practice of his profession. In addition to his technical knowledge he should have executive experience gained through the direction of work under contract, an analytical method of thinking and a familiarity with the costs of construction and operation. The fact that the Executive Board of the American Engineering Council, of which Herbert Hoover is president, represents 150,000 American engineers may have some influence on the selection of engineers for executive positions in the future but, on the other hand, no body of men is better fitted either scientifically or practically to direct departments having to do with transportation and construction than members of the engineering profession.

LETTERS TO THE EDITOR

Cost of Shipping Board Building Rentals in Philadelphia

My attention has been called to an article in the February number of Marine Engineering by Mr. Waldon Fawcett under the caption "How United States Government Reorganization Will Affect The Merchant Marine." Inasmuch as this article contains incorrect and misleading statements pertaining to costs of building rentals in Philadelphia, I am taking this means of setting you right in this respect.

The portion of the article in question states, in effect, that the United States Shipping Board Emergency Fleet Corporation pays an "aggregate of $472,000" for rent in Philadelphia and that this rental cost would be saved if all the offices were centralized in Washington. The article further implies that only a small part of this space is sub-leased to tenants and that such sub-tenants can "elect to vacate" at any time, thereby increasing cost of rentals to the Emergency Fleet Corporation. In view of this you will, no doubt, be interested in the following statement of facts:

The rent for the eleven story building at 140 North Broad Street, Philadelphia, which was leased in 1918, amounts to $290,725 per year but the larger part of this has since been sub-leased (as space became available through curtailment of our program as a result of the ending of the war), the total revenues to the Emergency Fleet Corporation being $379,977, or $89,252 per year greater than the rental cost. However, after deducting our expenses of operation, there is a net cost to us of but $18,748, and additional sub-leases now in process of negotiation will further reduce and may wipe out our rent cost entirely within a very short time. (We are operating this building for $50,000 a year less than the bid we received from a private concern.)

The five floors of the building at 329 South Broad Street, Philadelphia, cost us $78,000 for rent and maintenance, but sub-rentals amount to $38,464.41, therefore the net cost to us is $39,535.59 per year, but this building will be vacated by us at the expiration of our three year lease on May 5, this year, and this charge will therefore be eliminated.

The statement that the building at 253 North Broad Street costs $32,000 for rent is correct, but the article neglected to state that we have sub-leased it for $39,000 a year, thereby showing an excess of $7,000 in receipts per year over costs.

Taking the $18,748 net cost of rent at 140 North Broad, and the net cost of $39,535.59 for 329 South Broad, makes a total cost of $58,283.59. Deducting from this the clear profit of $7,000 for 253 North Broad Street, leaves the actual cost to the Emergency Fleet Corporation $51,283.59 per year, which is quite different from the "$472,000" cost figure in the article. After May 5, this year, this cost will be reduced to $11,748 per year, and may be wiped out entirely. As further evidence of the businesslike manner in which we handle our building matters, I will state that these costs for rent and operation in Philadelphia have been reduced from some $500,000 per year (during the war emergency in 1918 when it required 4,500 people in our executive offices to direct the gigantic shipbuilding program in this country) to $51,283.59 at present, and, as stated above, will be further reduced to $11,748 within two months. The inaccuracy and injustice of the statements in the article referred to must therefore be apparent.

The statement that a building at 921 Delaware Avenue costs the Emergency Fleet Corporation $95,000 for rent is hardly in accordance with the facts, as the Emergency Fleet Corporation does not occupy or hold the lease for these premises.

The Shipping Board also occupies some space for a branch office at 802 Chestnut Street, but as the article made no mention of this these figures are not included here.

Our sub-tenants cannot "elect to vacate" and thereby increase our rental cost, as stated in the article, as their leases with us do not terminate until the expiration of our own leases.

In endeavoring to point out the savings which would be accomplished if "the entire staff and complete files of the Shipping Board and Emergency Fleet Corporation could be accommodated in the huge building at Washington," you do not appear to appreciate the necessity of the Shipping Board maintaining district and local offices such as are needed for ship operations, purchasing, finances, etc., the details of which no private concern would attempt to handle in one central office, as you will undoubtedly admit; nor do you seem to realize that the employees of the Shipping Board in Philadelphia are those connected with the Delaware River District offices, except some 250 constituting the Home Office of the Division of Construction and Repairs which remained here in order to wind up the construction program from the shipbuilding center of this country.

The above discrepancies in the article are called to your attention so that you can correct the misleading impressions resulting from it, as a matter of fairness. I feel quite certain that you had no intention of making misstatements about the Shipping Board rental costs in Philadelphia, but since you have made them, and as the matter of building operations is one of those coming under my jurisdiction I cannot let your article in this respect pass unchallenged.

W. J. Bollenbeck,
Executive Assistant to the Director of Construction and Repairs, United States Shipping Board Emergency Fleet Corporation.
Philadelphia, Pa.

NEW BOOKS

Packing for Export Shipment

Export Packing. By C. C. Martin, with chapters by M. C. Fitzgerald, manager of transportation, General Electric Company; D. T. Abercrombie, formerly Lieutenant-Colonel, U. S. Q. M. C., and H. N. Knowlton, formerly Captain, U. S. Q. M. C. Pages, 723. Illustrations, over 350. New York, 1921: *American Exporter.*

To all who are interested in the development of foreign trade, the new book on export packing just published by the *American Exporter* will be a real aid. It is the first book which not only tells but also shows how to pack for shipment abroad every type of commodity and it is illustrated with over 350 reproductions from photographs and drawings of successful packing methods furnished by scores of the most experienced exporting manufacturers in the country. Aside from its usefulness to exporters, this book contains much information applicable to the problems of domestic shippers, especially those who make use of coastwise lines.

The contents of the book are well arranged for constant reference. Chapters are devoted to the principles underlying the use of each type of container, such as cases, crates, bales, barrels, bundles, cartons, tins, etc. Other chapters are devoted to the packing methods employed in shipping all classes of goods overseas.

The author has enlisted the collaboration of well-known authorities on export packing, several of whom have written chapters on special subjects. The book likewise contains much excellent and practical information derived from such organizations as the Forest Products Laboratory, the Supply Service of the War Department and others devoted to the investigation and improvement of packing materials and methods.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

CONDUCTED BY JAMES L. BATES

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

Horsepower of River Steamer

Q. (1115).—We would appreciate it very highly if you could give us information based on the following data:

What would be the aggregate horsepower required to drive four propellers, 6 feet diameter, 9 feet pitch, each at the rate of 245 revolutions per minute? Or, with a given resistance of two pounds per ton of displacement at five miles an hour, what would be the horsepower required to drive 1,700 tons at the rate of 20 miles an hour?

The vessel under consideration is of the shallow draft type for service on the Mississippi River. The main characteristics of the vessel are as follows:

Length on load waterline	280 feet
Beam	40 feet
Draft	3 feet
Displacement	750 tons
Midship section coefficient	1
Designed speed, miles per hour	20
Number of propellers	4
Diameter of propellers	6 feet
Pitch of propellers	9 feet
Revolutions per minute	245

The stern is a long, very easy rake, becoming more round as it progresses from the bottom, which is absolutely flat. The bottom of the propeller blades will be one foot above the dead flat of the boat and have 6 inches to 1 foot clearance between the top and the stern of the boat. Owing to the easy stern, the water running to the wheels should be solid and should have easy access to the wheels. O. F. B.

A. (1115).—The intended use of your boat upon the Mississippi River system together with the high speed which you contemplate justify the coarse pitch and number of propellers referred to. However, the design of a boat to make a speed of 20 miles per hour (assumed to be statute, not nautical miles) through channels of restricted depth is, at best, a problem of some difficulty. Its satisfactory solution involves an accurate knowledge of the effective horsepower necessary to attain the desired speed as well as a knowledge of the possibilities and limitations of the propellers contemplated.

The following information, taken from the "United States Coast Pilot," section E, published by the Department of Commerce, is pertinent in this connection:

"Below New Orleans, channel depths average from 60 to 75 feet, with a minimum at low river stages of about 40 to 42 feet.

"Baton Rouge is accessible to vessels of the deepest draft at all seasons of the year.

"There is a 28-foot channel to Natchez and an 18-foot channel to Memphis.

"There are 9- and 8-foot channels to Cairo and St. Louis respectively at low river stages.

"There is a 4-foot channel to St. Paul at the extreme low river stage."

Experiments carried out at the Experimental Model Basin, Washington, D. C., some years ago indicate that for the shallow draft type of boat at moderate speeds a depth of channel of about 80 feet simulates closely deep water conditions in so far as propulsion is concerned.

Admiral Taylor in "Speed and Power of Ships," pages 117 and 118, states that the relative minimum depth for which no increase in resistance occurs $= 10\,H\,\frac{V}{\sqrt{L}}$, in which H = draft, V = speed in knots, and L = waterline length. He states further that this formula applies primarily to vessels of normal form having block coefficients up to .65 and values for $\frac{V}{\sqrt{L}}$ not greater than .9. The extreme proportions of river vessels in general and the high speed of this one in particular would seem to require a much greater channel depth to obtain the equivalent of deep water conditions than that given by the formula. A decrease to a 25-foot depth of channel does not seriously increase the power required for speeds below 8 or 9 knots (speed length ratios of .65 and .73 respectively), but at 13 knots the effective horsepower in the 80-foot channel is 365 as compared with 1,050 in the 25-foot channel. This increase of power with decrease in channel depth becomes even more serious at depths of 15 and 10 feet. These results are in general accord with results of similar experiments made elsewhere.

In view of these facts, the writer strongly urges that model basin experiments be carried out at channel depths corresponding to those which the boat is expected to encounter in service before the final details of either the hull or propellers are fixed. These experiments should be such as to furnish the curves of effective horsepower over the entire speed and displacement ranges contemplated. It would also be desirable, though not of the same importance, to try the model self propelled. It is believed that only by means of such experiments can the actual performance of the boat in service be satisfactorily forecast.

1	2	3	4	5	6	7	
$\frac{V}{\sqrt{L}}$	Residual		Frictional		Total *E.H.P.* Bare Hull	Speed, Knots	Speed, Miles
	Pounds per Ton Displacement	*E.H.P.*	Pounds per Ton Displacement	*E.H.P.*			
.4	1.28	19.8	4.72	72.8	92.6	6.7	7.71
.5	2.31	44.5	7.10	137	181.5	8.38	9.64
.6	3.21	74.2	9.83	227	301.2	10.05	11.56
.7	5.48	148	13.10	353	501	11.71	13.46
.8	9.46	292	16.74	516	808	13.40	15.40
.9	15.50	536	20.75	718	1,254	15.05	17.30
1.0	22.41	864	24.90	960	1,824	16.73	19.25
1.1	31.08	1,318	29.80	1,265	2,583	18.40	21.17
1.2	42.35	1,960	35.30	1,632	3,592	20.08	23.10

NOTE.—Column (3) = column (2) × .00307 × V × Δ. Column (5) = column (4) × .00307 × V × Δ. Column 6 = sum of columns (4) and (5).

Owing to the element of uncertainty introduced by a channel of varying though generally small depth, vessels designed for such service are frequently standardized and tried on a deep water course. On this account, and because the only data in the writer's possession which extend to the high speeds contemplated are for deep water, the following investigations have been carried out upon a deep water basis.

The derivation of the curve of effective horsepower, bare hull, is shown in the table at the bottom of the opposite page with an explanation of the data in the several columns.

The above results are plotted for convenient use on Fig. 1. There is also shown on the same plate a curve for a channel depth of 15 feet derived from the same basic data as those used below. This latter curve is intended only to illustrate the cost in power of driving in very shallow water as compared to driving in deep water.

The following design of propeller is based upon the latest modified Dyson method:

FIRST TRIAL

$L.W.L. = 280$ feet	$\frac{2 \times L.A.B.}{H_1} = 18.67$
$B = 40$ feet	$s = .18$
$H = 3$ feet	$1 - s = .82$
DS (tons) $= 750$	Type of vessel $= 3$
$\frac{B}{L.W.L.} = .1429$	$v = 20$ miles $= 17.37$ knots
$N.B.C. = .781$	$e.h.p._B = 2{,}080$
$K.B.C. = .71$	‡ $K = 1.36$
$H \div B = .075$	P feet $= 9$
$S.B.C. = .48$	D feet $= 6$
*$H_1 = 7.5$	Number of blades $= 3$
†$L.A.B. = 70$ feet	Number of shafts $= 4$

$\frac{PA}{DA} =$	.25	.30	.35	.4
$TS =$	5,981	6,766	7,630	8,516
$IT_D =$	2.73	3.73	4.81	6
$C =$	1	1	1	1
$I.H.P. = \frac{TS \times IT_D \times P \times D}{\pi \times 291.8 \times C} =$	962	1,486	2,161	3,009
$S.H.P. = I.H.P. \times .92 =$	885	1,351	1,988	2,768
$P.C. =$	.70	.68	.652	.62
$E.H.P. = I.H.P. \times P.C. =$	673.2	1,011	1,409	1,866
$E.H.P.$ (total) $=$	2,693	4,044	5,636	7,464
$V = \frac{(1-s) \times P \times TS}{101.33 \times D \times \pi} =$	23.11	26.14	29.48	32.91
$\frac{v}{V} =$	.7517	.6644	.5892	.5278
$\frac{e.h.p.}{E.H.P.} =$	.7726	.5144	.369	.2786
Cavitating $=$	No	No	Yes	Yes
$Z_p =$	.117	3		
$10^{Z_p} =$	1.309	1.995		
$S.H.P.$ (total) $=$	3,540	5,404		
$S.H.P._p = S.H.P. \div 10^{Z_p} =$	2,704	2,708		
$S.H.P._d = S.H.P._p \times K =$	3,678	3,684		
$Z_s =$	.268	.42		
$10^{Z_s} =$	1.854	2.630		
$S = \frac{S \times SHP_d}{S.H.P.} \times 10^{Z_s} =$	.3467	.3227		
$1 - s =$	.6533	.6773		
$R_d =$	299	289		

* Height of tunnel roof above baseline at position of propeller.

† Length along keel from opening of tunnel at forward edge to position of propeller. From investigations of similar vessels, this distance was found to be about 25 percent of $LWL = 280 \times .25 = 70$ feet.

‡ A constant for this class of vessel. Includes appendage resistance.

It will be seen from the above calculations that with a diameter of 6 feet and a pitch of 9 feet a standard form of propeller blade up to .3 projected area ratio results in revolutions much above the 245 desired. It will also be seen that to increase the projected area ratio above .3 throws the propeller into cavitation.

The next step is to design a four-blade propeller, having what is known as a "fan shaped" blade. A "Basic" diameter (D^1) will be assumed and with this diameter together with the final "Basic" projected area ratio $\left(\frac{PA}{DA}\right)^1_4$ blades may be drawn of the standard Dyson form, the tips cut off to the desired diameter of 6 feet and the removed area added to the sides as far out toward the circumfernce as possible. The projected area of the resulting propeller will be the same as that of the calculated "Basic" propeller. The contour of the "Basic" propeller blades should conform to the Dyson standard blade shape corresponding to the three (3) blade projected area ratio $\left(\frac{PA}{DA}\right)^1$

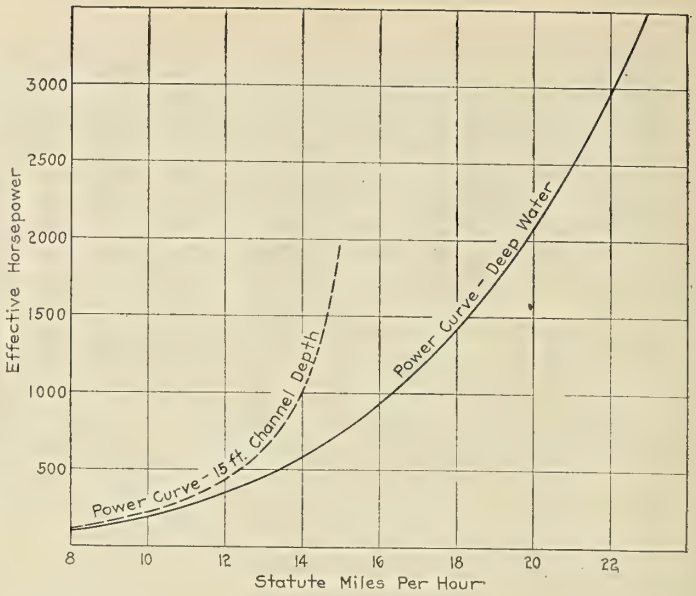


Fig. 1

SECOND TRIAL

$\left(\frac{e.h.p.}{E.H.P.}\right)_{pg} =$	.3	.4	.5	.6	.7
$Z_{pg} =$	.5445	.4144	.313	.231	.1613
Log $K =$	.13354	.13354	.13354	.13354	.13354
$Z_p = Z_{pg} + \log K =$	.67804	.54794	.44654	.36454	.29484
$\frac{e.h.p.}{E.H.P.} =$	.223	.300	.371	.445	.52
$e.h.p. =$	2,080	2,080	2,080	2,080	2,080
$E.H.P.$ (total) $= e.h.p. \div \frac{e.h.p.}{E.H.P.} =$	9,328	6,934	5,607	4,674	4,000
$E.H.P.$ (one shaft) $= E.H.P. \div 4 =$	2,332	1,733	1,402	1,169	1,000
$v =$	17.37	17.37	17.37	17.37	17.37
$\frac{v}{V} =$	.652	.714	.771	.822	.869
$V = v \div \frac{v}{V} =$	26.64	24.33	22.53	21.13	19.99
$C =$	2.491	2.491	2.491	2.491	2.491
D (Basic) $=$	7.0625	7.0625	7.0625	7.0625	7.0625
$\frac{PA}{DA} \times ET_p = \frac{E.H.P. \times C}{(D^1)^2 \times V} =$	4.389	3.571	3.12	2.774	2.508
$\left(\frac{PA}{DA}\right)^1 =$	.39	.334	.301	.277	.260
$\left(\frac{PA}{DA}\right)^1_4 = \frac{4}{3}\left(\frac{PA}{DA}\right)^1 =$	.5199	.4453	.4013	.3693	.3467
$P.C.^1 =$	.5445	.59	.618	.64	.6545
$I.H.P.^1 = E.H.P. \div P.C.^1$ (one shaft) $=$	4,283	2,937	2,268	1,826	1,528
$I.H.P.^1$ (total) $=$	17,130	11,748	9,072	7,306	6,111
$S.H.P.^1$ (total) $= I.H.P.$ (total) $\times .92 =$	15,760	10,808	8,346	6,721	5,622
$Z_p =$	.679	.5445	.447	.366	.294
$10^{Z_p} =$	4.7753	3.5035	2.799	2.3225	1.968
$S.H.P.^1_p = S.H.P.^1 \div 10^{Z_p} =$	3,300	3,085	2,982	2,894	2,865
$S.H.P.^1_d = S.H.P.^1_p \times K =$	4,488	4,196	4,055	3,936	3,897
$S.H.P._d = S.H.P.^1_d \times \frac{D^1}{D} =$	5,283	4,938	4,773	4,633	4,587

$TS =$	8,330	7,360	6,795	6,400	6,125
$P = \dfrac{V \times \pi \times D^1 \times 101.33}{(1-s) \times TS} =$	8.770	9.064	9.092	9.053	8.95
$Z_s =$	.445	.332	.236	.160	.094
$10^{z_s} =$	2.7864	2.1479	1.7214	1.4452	1.2416
$S = \dfrac{S \times S.H.P.^1_a}{S.H.P.^1} \times 10^{z_s} =$	.1428	.1501	.1505	.1523	.1549
$1 - s =$	.8572	.8499	.8495	.8477	.8451
$R^1_a = \dfrac{v \times 101.33}{P \times (1-s)} =$	234.1	228.5	227.8	229.3	232.7
$R_a = R^1_a \times \left(\dfrac{D^1}{D}\right)^{1/2} =$	254	247.9	247.2	248.8	252.5

The characteristics of the propeller selected would be:

Basic diameter = 7 feet ¾ inch
Actual diameter = 6 feet 0 inch
Pitch = 9 feet 1 inch

$\left(\dfrac{PA}{DA}\right)^1_4$ projected area ratio, "Basic" = .4013

$\left(\dfrac{PA}{DA}\right)$ projected area ratio used in laying out blade forms = .301

$\left(\dfrac{PA}{DA}\right)_4$ projected area ratio, actual = .556

Actual projected area = 15.72 square feet
S.H.P., total about = 4,770
R.P.M., about = 247

While these characteristics do not exactly meet the requirements which you laid down, they are very close, and as the result of a number of trails, not tabulated herein, are believed to represent as satisfactory a solution of the problem as can be reached without the aid of model experiments.

The steps have been set down in detail above, as it is felt that the results themselves are of more value when the method of their derivation is available for reference.

Attention is particularly invited to the fact that the power given is net, no margins of any kind having been introduced.

Subsequent to the completion of the above work, propeller investigations on another vessel indicated the possibility of designing a better propeller for this ship than that above described. An investigation along the lines indicated below resulted in the design of such a wheel.

Assume a three (3) bladed propeller, having what is known as a "fan shaped" blade. "Basic" diameter (D^1) assumed and with this diameter together with the final "Basic" projected area ratio $\left(\dfrac{PA}{DA}\right)^1$ blades may be drawn of the Dyson standard form, the tips cut off to the desired diameter of 6 feet and the removed area added to the sides as far out toward the circumference of the 6-foot blade as possible. The projected area of the resulting propeller will be the same as that of the calculated "Basic" propeller. The contour of the "Basic" propeller blades should conform to the Dyson standard blade shape corresponding to the projected area ratio $\left(\dfrac{PA}{DA}\right)^1$.

Upon this basis the propeller characteristics and performance are:

Basic diameter	7 feet 0 inches
Actual diameter	6 feet 0 inches
Pitch	9 feet 8 inches
$\left(\dfrac{PA}{DA}\right)'$ Projected area ratio used in laying out blade forms	.304
Projected area ratio, actual	.4137
Actual projected area in square feet	11.7
S. H. P. (total)	4,300
R. P. M.	245

Stealer Plates

Q. (1120).—An argument having arisen as to the term applied to the plates in Fig. 1, marked with a question mark, I wish to have your counsel on the matter. *A* contends that the plates in question are called stealers, while *B* contends that they are short strakes and that the plate of the strake markel *X* is the stealer. We have looked up all reliable sources of information that we can procure and can find no definite information.
C. G. B.

A. (1120).—The distinguishing feature of a stealer plate is its taking the place of two plates in adjacent strakes or its forming the ending of one strake while at the same time continuing the adjacent strake. The stealer plate is sometimes

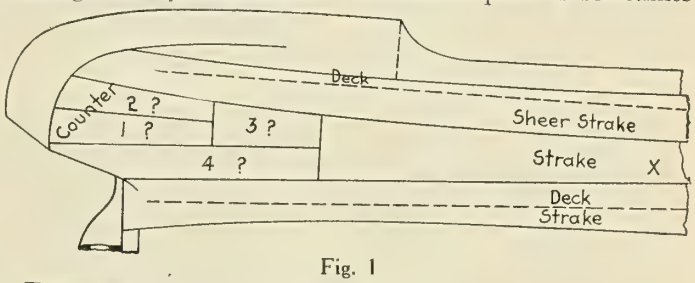


Fig. 1

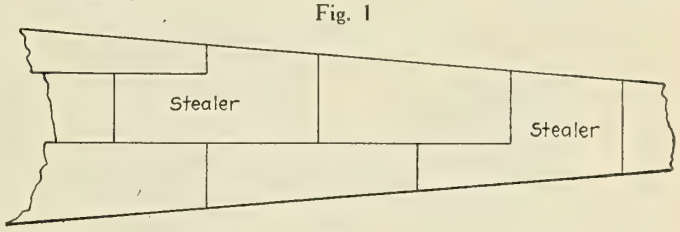


Fig. 2

worked as shown in Fig. 2, rather than as in your sketch, in order to secure a more effective shift of butts. In any case, however, the change in the total width of the plated surface, whether in the forward or after part of the vessel, is the occasion for the introduction of the stealer.

In Fig. 1 the strakes are narrowing from the counter forward. In accordance with the foregoing, therefore, strake 4 and either 1 or 2 are drop strakes and the aftermost plates of strakes 3 and *X* are stealers.

Official figures of the Board of Trade covering the entrance and clearance of vessels with cargo at British ports in 1920 show an increase of nine million tons net over similar returns for the year 1919, and a gain of almost 24 million tons over the figures for the year 1917. Of the total entrances and clearances in 1920, approximately 49 million tons were British ships.

PERSONAL MENTION

Paul H. Macneil, dry dock engineer, has severed his connections with the Crandall Engineering Company, East Boston, Mass., and has accepted the position of dockmaster with Theo. A. Crane's Sons Company, Brooklyn, N. Y. Besides the three existing floating dry docks at this plant, a new 12,000-ton floating dock is rapidly nearing completion. This added facility, coupled with the acquiring of adjacent land until recently occupied by Gokey & Company, will make of the Crane Company one of the largest and best equipped repair and dry dock plants in the port of New York.

John Hunter, the well-known power plant engineer, who as was announced in our last issue has just accepted the position of chief engineer of the Heine Safety Boiler Company, was born in Scotland, where he was educated and served his engineering apprenticeship. He entered the marine service as junior engineer on the Red Star Line S. S. *Westernland*. Later he was promoted to first assistant engineer on the S. S. *Friesland* of the same line. In 1895 he was transferred as senior first assistant engineer to the S. S. *St. Louis* of the American line, then being built at Cramp's shipyard in Philadelphia. He served in this capacity until the outbreak of the Spanish American War in 1898, when he was appointed chief engineer of the *St. Paul,* operated by the United States Navy, with Captain Sigsbee in command. When the *St. Paul* was returned to commercial service between New York and Southampton he continued as chief engineer. In August, 1905 Mr. Hunter accepted the position of chief engineer of power plants of the Union Electric Light & Power Company, St. Louis, where he had charge of the design, construction and operation of the electric generating stations of the company, which supplied practically all the lighting, industrial power, as well as a considerable share of the street railway power used throughout the city. The largest station of this system, the Ashley Street Station, was the scene of much pioneer development work. For instance, when Mr. Hunter assumed charge of the plant it was rated at 12,000 kilowatts, and in the same building by the adoption of ultra-modern improvements he increased the power to 116,000 kilowatts. During this period he had much to do with the pioneer development of high capacity turbine units, condensers, improved methods of setting boilers and designing furnaces for high capacity and forced operation. In 1913 he was associated with Mr. Hugh L. Cooper, of the Keokuk Water Power Company, in the building of the hydro-electric plant, which when completed furnished the Union Electric Company in St. Louis with 45,000 kilowatts transmitted at 100,000 volts. In 1917 Mr. Hunter was called East by the United States Government to assist in the shipbuilding program. He was first detailed as Government representative in charge of the Submarine Boat Company, and later transferred to the Standard Shipbuilding Corporation, Shooters Island, N. Y. Under his supervision the number of employees was increased from something over 400 in 1917, to approximately 4,500 at the time the armistice was signed.

John Hunter

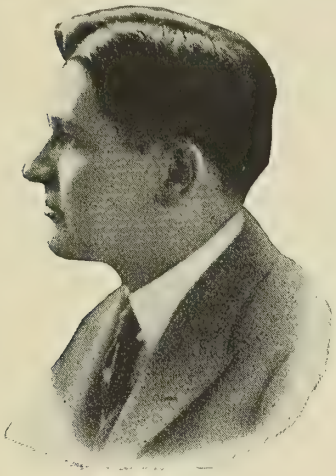
During the war this yard completed twenty-five 7,500 deadweight ton cargo boats, two mine sweepers, two fruit and passenger steamers, and they now have nearing completion four 8,400 deadweight ton oil tankers. Mr. Hunter has served seven years as a member of the prime movers' committee of the National Electric Light Association, and five years as a member of the American Uniform Boiler-Law Society. He is a past president of the Engineer's Club of St. Louis, and was a member of the jury of awards, Department of Machinery, at the San Francisco Exposition. In the American Society of Mechanical Engineers he was member of the Council as manager for three years, and as vice-president for two years. Mr. Hunter has a host of friends in the central station and power plant field who will welcome his entry into a position where he can bring his experience to bear on the design and operation of central stations throughout the country.

David Currier, Jr., sailed from New York on March 5, for Buenos Aires, Agentina, where he will take up the duties of exclusive surveyor for the American Bureau of Shipping for that port and also with supervision over the ports of Rosario and Montevideo. Mr. Currier is a graduate of the engineering department of Brown University with special training in naval architecture at the Massachusetts Institute of Technology. After graduation he served an apprenticeship as a ship fitter in the yards of William Cramp & Sons Ship and Engine Building Company, Philadelphia. Since that time he has been engaged as a draftsman, inspector and purchasing agent at several of the leading shipyards in the country. He has also had service at sea in the engine room of one of the Hog Island ships. The business of the American Bureau of Shipping at River Platte ports has increased to such an extent that it was deemed advisable to have an exclusive surveyor located in that vicinity. Capt. L. A. Blake, of Maine, heretofore non-exclusive surveyor at Buenos Aires, will be retained in the same capacity to act as such times as his services are necessary.

G. Norman Scott, formerly chief engineer of the Standard Shipbuilding Corporation, Shooters Island, New York, is president of Scott Brothers & Surtees, Inc., Whitney Central Building, New Orleans, La., a new company which has been formed to carry on the business of consulting engineers, naval architects and marine surveyors. For some years past Mr. Scott has been identified with American shipbuilding at the yards of the Chester Shipbuilding Company, Chester, Pa., and of the Standard Shipbuilding Corporation, Shooters Island, New York. He was chief engineer of both companies and at the Standard yard for some time had complete charge of both hull and engine work. Mr. Scott received his early training at the Glasgow Technical College and in the shipyards of Messrs. Alex. Stephens & Sons on the Clyde, after which he had a number of years actual sea experience before coming to America. The new firm in New Orleans will be associated with the old established firm of Scott & Surtees, 80 Broad Street, New York, and will handle work all along the Atlantic and Gulf coasts.

G. Norman Scott

M. F. Emrich, formerly vice-president and general manager of the Campbell Paint and Varnish Company, St. Louis, Mo., a subsidiary of the Glidden Company, has recently been appointed general sales manager of the Industrial Division of the Glidden Company, with headquarters at Cleveland, Ohio. Mr. Emrich has been connected with the Glidden Company for many years in various capacities. His experience covers every phase of the paint and varnish industry. During his many years of service with the Glidden Company he has shown exceptional ability and has advanced steadily. In the Industrial Division are experts not alone on proper marine finishes but on the method of application as well. It is confidently expected that in his new capacity Mr. Emrich will develop the Industrial Division to an even greater extent than ever before.



M. F. Emrich

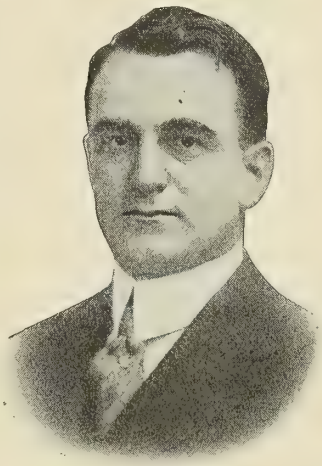
Charles H. True has been elected vice-president of The Superheater Company, in charge of production, with offices at East Chicago, Ind. Mr. True was born in Boston, Mass. He was educated at the public schools of Schuyler, Neb., and the University of Nebraska, graduating in 1898, with the degree of electrical engineer. Immediately upon graduation he entered the service of the Union Pacific Railway, at Omaha, and served in both the locomotive and car shops. In 1902 he became roundhouse foreman at Grand Island, Neb., and in 1903 resigned from the Union Pacific to take a similar position at Trenton, Mo., with the Chicago, Rock Island & Pacific Railway. In October of the same year he was transferred to the Silvis shops as assistant superintendent of shops. In 1905 he accepted the position of mechanical engineer with the Railway Materials Company at Chicago and was engaged in the design of metallurgical furnaces for blacksmith shops and boiler shops. In 1910 he refitted and took charge of the Phoenixville, Pa., plant of this company. In 1912 he resigned his position with the Railway Materials Company to become works manager of the Locomotive Superheater Company at East Chicago, Ind., which position he held at the time of his recent election to the vice-presidency. During the time he was works manager he was actively associated in the mechanical development of superheaters for locomotive, marine and stationary boilers. Mr. True is a member of the American Society of Mechanical Engineers and other engineering societies.

C. H. True

Henry B. Oatley was recently elected vice-president in charge of engineering of The Superheater Company, with offices at 30 Church street, New York. Mr. Oatley was born at Rochester, N. Y., and attended the public schools at that place. He received his engineering education at the University of Rochester and the University of Vermont, graduating from the latter in 1900 with the degree of mechanical engineer. Upon graduation he entered the service of the Schenectady Locomotive Works. His experience while on this work was very broad, embracing locomotive design and shop testing. He was associated with F. W. Cole in the early development of the superheater for locomotives by that company. In 1910, upon the formation of the Locomotive Superheater Company, he accepted the position of mechanical engineer, and in 1916 was appointed chief engineer for this company, which position he held at the time of his election as vice-president. In April, 1917, he was granted a leave of absence and served as an officer in the United States Navy on the battleships *Ohio* and *Indiana*. Mr. Oatley is a recognized authority on superheating, and has been an active factor in its development. He is in a large measure responsible for putting superheater design upon a practical operating and manufacturing basis in locomotive, marine and stationary practice, and without sacrifice to efficiency has developed uniformity of sizes and design.

H. B. Oatley

Gilbert E. Ryder has been elected vice-president of The Superheater Company, in charge of sales, with office in New York. He was born in Minneapolis, Minn., in 1880. He studied engineering at the University of Wisconsin and also at the University of Illinois. His railroad experience began with apprenticeship on the Chicago, Milwaukee & Saint Paul Railway and included service as a journeyman in the mechanical department of that road at Dubuque, Ia., Ottumwa, Ia., and West Milwaukee, covering five years. Engineering experience followed in the fuel testing bureau of the technologic branch of the United States Geological Survey. He later served the city of Chicago as deputy smoke inspector in charge of locomotives, which placed him again in intimate contact with the locomotive fuel conservation problem. This was followed by editorship of the Railway Review of Chicago, after which he entered the service of the Locomotive Superheater Company ten years ago. He became a member of the service department and later took charge of that department, which today is responsible for the operation of 30,000 superheaters on locomotives in this country alone, in addition to stationary and marine applications.



G. E. Ryder

Shipbuilding and General Marine News

Contracts for New Ships — Shipyard Improvements — Engineering Projects—Improved Appliances—Personal Items

EQUIPMENT ASSOCIATION OF AMERICA ORGANIZES PERMANENT BODY FOR MARINE FIELD

Object is to Advance Interests of Members—Is 100 Percent American and Favors Adequate Merchant Marine for America—Holds First Election of Officers

A meeting of the Marine Equipment Association of America, for the purpose of forming a permanent organization, was held at the Hotel McAlpin, New York, on March 28.

The object of this association is to advance the interest of its members; to promote good will among those who specify, those who buy and those who sell marine equipment, supplies and stories; to promote and supervise marine exhibitions; to cooperate with other associations in the marine field, to the end that their efforts for the advancement of designing, building and operating ships shall be most productive. This organization is 100 percent American, and favors an American merchant marine of adequate size to meet the commercial and military needs of the country. One hundred and thirty-nine concerns have already signified their intention of joining the association and 75 representatives were present at this meeting.

The officers elected were as follows:

President—Col. E. A. Simmons, president, Simmons-Boardman Publishing Company, New York.

Vice-President—W. H. Todd, president, Todd Shipyards, New York.

Secretary and Treasurer—K. L. Ames, Jr., American Steel Foundries, Chicago, Ill.

EXECUTIVE COMMITTEE

E. B. Williams, B. F. Sturtevant Company, Boston, Mass.

F. L. Andrews, general manager, Hyde Windlass Company, Bath, Me.

M. L. Katzenstein, Worthington Pump & Machinery Corporation, New York.

Walter M. McFarland, general manager, Babcock & Wilcox Company, New York.

H. C. Davis, Row & Davis, New York.

Frank Hatch, vice-president, Shepard Electric Crane & Hoist Company, Montour Falls, N. Y.

H. R. Stephen, vice-president, Submarine Boat Corporation, Newark, N. J.

G. W. Selby, president, Marine Decking & Supply Company, Philadelphia, Pa.

J. C. McQuiston, director of publicity, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

W. P. Smith, William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa.

William Stayton, president, Baltimore Steamship Company, Baltimore, Md.

F. C. Bradbury, Crane Company, Chicago, Ill.

M. Sarles, Pyle-National Company, Chicago, Ill.

H. L. Hibbard, Cutler-Hammer Manufacturing Company, Milwaukee, Wis.

J. H. Redhead, National Malleable Castings Company, Cleveland, Ohio.

H. F. Alexander, president, Pacific Steamship Company, Seattle, Wash.

W. M. Wampler, Coen Company, San Francisco, Cal.

Fruit Steamer Has Successful Trial

The twin screw steamer *Choluteca* after a very successful trial trip upon which she developed a speed of 15 knots was delivered March 11th by the Newburgh Shipyards, Inc., of Newburgh, N. Y., to the Cuyamel Fruit Company of New Orleans, La.

This vessel, which is 301 feet 6 inches in length, 42 feet broad and 24 feet 10¾ inches molded depth, is of the shelter deck type with steel upper deck all fore and aft and is designed expressly for the carrying of bananas between Puerto Cortez and New Orleans, having a deadweight carrying capacity of 2,100 tons on 16 feet 6 inches mean draft.

The machinery consists of two sets of reciprocating engines, each developing 1,500 indicated horsepower.

Shipping Board Finances

In a report to the Senate written by Commissioner Teal, it is stated $395,000,000 will be needed by the Shipping Board for its various activities during 1921, including completion of its construction program. A deficit from operations of $38,000,000 is expected in the first six months of this year as compared with a profit of $25,000,000 in the last six months of 1920. Commissioner Teal recommends a direct or indirect subsidy.

Peak of Depression at Hand

Shipping Board officials assert that withdrawals of vessels from operation are decreasing and that assignments are increasing. They expect the peak of the depression to be over in about two or three weeks.

TO BUILD TANKERS

Report Contract Placed for Six Ships Costing $15,750,000

The contracts for the Diesel motor equipment to be installed in the six tankers proposed to be built by the Norway Pacific Construction & Dry Docks Company, in Everett, Wash., have been awarded to the American British Manufacturing Company, Bridgeport, Conn., and Providence, R. I., according to announcement credited to M. G. Thomle, president of the company, and received by Marine Engineering.

Arrangements for pumps and piping have been made and steel orders have been placed in the East. The beginning of work on the six tankers, which Mr. Thomle says have been contracted for, will await the return to Seattle of M. E. Barham, receiver of the yard, now in the East completing financial arrangements.

Half of the funds will be provided by foreign capital, it was stated, and the remainder in this country. The yard at Everett is fully equipped, and $150,000 will be spent in making the three ways ready for work, the contract to be completed in 1922.

It was estimated that the six tankers, the ownership of which has not yet been announced, will involve approximately $15,750,000.

ELECTRIC DRIVE CONTROL

Disaster Averted by Invincible's New Equipment

An account of the recent collision between the Army Transport *Madawaska* and the U. S. Shipping Board vessel *Invincible* has just been obtained from Commander V. V. Woodward, Manager of the Repair Department of the U. S. Shipping Board and Mr. H. B. Taylor, chief turbine engineer of the Shipping Board.

The *Invincible* had just been equipped with the electric drive and was bound for Norfolk for cargo. Commander Woodward and Mr. Taylor were aboard to note the performance of the equipment on the initial trip. They had just come up from the engine room and were standing on the bridge when the *Madawaska* was first sighted, about a ship's length away. The weather was extremely heavy and the *Invincible* was running at a reduced speed of about 6 knots. As soon as the *Madawaska* was sighted, full-speed astern was rung from the bridge and in three seconds from the time that the signal was answered in the engine room, the *Invincible's* propeller was turning up 100 revolutions full speed astern.

They state that the only thing that prevented the accident from being much more serious was the rapidity of control of the electric drive, as when the ship struck, the *Invincible's* motor was reversed and going full-speed astern.

TANKERS PREDOMINATE IN MILLION AND A HALF TONNAGE NOW UNDER CONSTRUCTION

American Bureau of Shipping Figures Show 101 Tank Ships Ordered or Under Way, 94 of Which Are for Private Owners—330 Merchant Ships Building

Construction of tankers is much greater proportionally for work now under way for private account than that for the Shipping Board, according to returns compiled by the American Bureau of Shipping. It is estimated that more than half of all the steel merchant tonnage under construction in American shipyards at the beginning of this month represent the tanker type of vessel.

Ships of all types building for both Government and private account at the beginning of the month aggregated 330 of 1,434,146 gross tons of which 54 boats totaling 435,412 gross tons were for the account of the Shipping Board and 276 of 998,834 gross tons were for private owners. The Government's construction work in hand, therefore, has now reached the point where it is considerably less than half the building for private account. The division of the work under way by types of ships is as follows (figures being in gross tons):

	Shipping Board	Private Account
Tankers	51,000	720,093
Freighters	195,412	278,741
Passenger and cargo	189,000	.....
Total	435,412	998,834

Practically all of the vessels building are being constructed either to burn oil alone or so that they can be converted from oil to coal burners.

Tankers ordered or under way totalled 101 of 756,354 tons. Seven of 51,000 tons were for the Shipping Board and 94 of 705,354 tons for private owners. In addition 30 unpropelled oil-carrying barges of 14,739 tons were under way, all on private account.

Cargo ships ordered or under way totalled 95 of 432,078 tons, 66 of 236,666 tons being on private account. In addition 86 barges of 42,075 were under way, all on private account. Of the freighters 53 of 252,591 tons were fitted with oil burners and 26 of 169,565 equipped to burn either oil or coal. Combination passenger and cargo liners building or ordered totalled 18 of 189,000 tons, all on Shipping Board account.

Ten Above 10,000 Tons

Of ships building or ordered eight of 108,000 total tonnage were between 13,000 and 14,000 gross tons, two of 21,200 total were between 10,000 and 11,000 tons; seven of 69,000 total between 9,000 and 10,000 tons, 21 of 183,494 between 8,000 and 9,000, 21 of 158,277 between 7,000 and 8,000 and 28 of 183,894 between 7,000 and 8,000.

Six freighters of 30,100 total tonnage and four tankers of 30,700 tons were to be equipped with Diesel engines, 29 cargo ships of 183,800 tons and five tankers of 36,000 tons were to have steam turbine drive, while 56 freighters of 190,098 tons and 94 tankers of 690,904 tons were to have reciprocating engines. Of the passenger and cargo liners three were to have reciprocating engines and 15 turbines.

Out of the 326 ships under way or ordered, 84 have not yet reached keel laying. Out of 383 ways in American yards in operation 154 ways were empty March 1.

Bethlehem Plant in Lead

Bethlehem Shipbuilding led with 31 ships of 264,900 gross tons ordered and under way at its five plants. Eight of these ships have not yet reached keel laying. Out of its total of 45 ways 22, or approximately half, were idle.

New York Shipbuilding was second with 20 ships of 183,600 tons ordered and under way. Out of its 22 ways only 2 were idle.

Federal Shipbuilding was third with fifteen ships of 110,000 tons ordered and under way at its Chickasaw and Kearny plants. Out of its twenty-two ways seven were idle. Sun Shipbuilding was fourth with eleven ships of 93,199 tons ordered and under way. All eight of its ways being filled and three of the ships not as yet to keel laying.

Moore Shipbuilding was fifth with ten ships of 73,439 tons under way and all ten of its ways filled. Merchants Shipbuilding came sixth with ten ships of 67,140 tons on the ways and two of its ways idle, while Newport News Shipbuilding came seventh with five ships of 58,700 tons under way and three of its eight ways idle.

Australian Shipping Strike Ended

The shipping strike in Australia has ended, the men's leaders having adopted a conciliatory attitude, and are anxious that work should be resumed immediately. Ships will be named at the earliest possible moment. The differences regarding manning were decided by a joint committee, the unions giving pledges of continuity of employment and the abandonment of attempts to control appointments. It was also agreed that the settlement of disputes should be by constitutional means.

West Coast Shipping Improves

Although there is some pessimism among the shippers and steamship operators at Seattle and other Pacific ports, shipping has been improving gradually since the first of the year. In the intercoastal trade several new lines have come to Seattle since January, and still there is enough cargo to be had for all the carriers dispatched from Puget Sound and Columbia River. In more than a half dozen cases the coast-to-coast freighters have had to leave tons of cargo behind because their holds were filled.

CANADIAN INDUSTRY

Millions of Dollars Invested in Shipbuilding Business

The Canadian ship and boat building industry, which received such an impetus during the war, represented a total investment of $72,000,000 in 1919, according to the Dominion Bureau of Statistics. Of this amount $70,854,028 was invested in shipbuilding plants, nine-tenths of which turned out steel vessels. At the outbreak of war there were only two thoroughly up-to-date steel shipbuilding plants in Canada but at the end of 1919 there were nineteen.

The report divides the plans into shipbuilding and boatbuilding but does not subdivide the former into those which turn out steel and wooden vessels respectively. In 1919 there were 78 shipbuilding plants distributed among the provinces as follows: British Columbia, 14; Manitoba, 1; New Brunswick, 4; Nova Scotia, 37; Ontario, 11; Quebec, 11. In the Maritime Provinces the plants have been small, though in 1920 that of the Halifax Shipyards, Limited, a thoroughly modern steel plant, began turning out steel vessels. The number of boatbuilding plants in all Canada was returned as 99.

The capital investment of $70,854,028 in shipbuilding plants was divided as follows: Ontario, $29,911,885; Quebec, $27,614,498; Nova Scotia, $8,732,419; British Columbia, $6,541,003; New Brunswick, $54,223. Ontario with an investment of $680,493 is the center of the boatbuilding industry. The total number of employees in all branches of the industry in 1919 was 28,000, of which 25,260 were in shipbuilding plants, the total wages and salaries paid in that year being $30,750,000.

The total cost at the works of materials used in 1919 was $36,500,000, the total value of all products of the yards being $88,300,000. In this connection it may be said that included on this figure is $9,176,000 for vessels built but not launched, also repairs valued at $8,282,000. The number of vessels completed during the year was 281, the gross tonnage being 3,604,539.

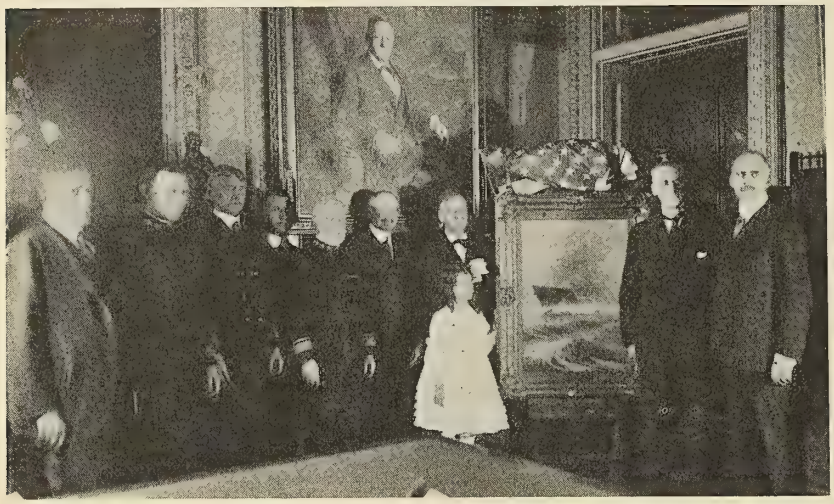
In 1919, the value of vessels exported was very large, the figures for the nine months ending December being $36,752,184 as compared with $15,280,494 for the same period in 1918. During the nine months ending December, 1920, the value of these exports had fallen to $16,832,468.

Bethlehem Corporation to Have Busy Year

Orders for new construction on hand will keep the principal shipbuilding plants of the Bethlehem Steel Corporation well employed during the current year, according to Charles M. Schwab, chairman of the Board of Rirectors of this corporation. In his statement, Mr. Schwab says that in the business readjustment representatives of the employees of the corporation have met the managers in a fair and co-operative spirit. According to Mr. Schwab the value of unfilled orders on December 31, last, was $145,286,637, as compared with $251,422,545 on December 31, 1919.

DEVELOPMENT OF STEAM TURBINE ELECTRIC DRIVE SHOWS NOTABLE PROGRESS

President of General Electric Company Presents Navy Department With Portrait of The "New Mexico"



A magnificent specimen of sea and ship portraiture, a canvas of the first electrically driven battleship in the world, the *U. S. S. New Mexico,* was presented to the United States Navy Department by E. W. Rice, Jr., president of the General Electric Company, on February 28. It was accepted by Secretary Daniels.

This painting, pronounced by Rear Admiral W. S. Benson, head of the U. S. Shipping Board, the finest he had ever seen, was executed by Walter L. Greene, artist of the Publication Bureau of the General Electric Company.

In presenting the picture to Secretary Daniels, Mr. Rice said:

"Mr. Secretary of the Navy and Gentlemen:

"The Navy Department of our Government has contributed more to important advances in engineering than is generally appreciated by many well-informed people.

"I will not attempt even to mention the numerous developments which the navy has either stimulated or originated, but I do wish to briefly outline one of the big forward steps of recent years in which the navy has played a great and indispensable part, namely the development of the steam turbine electric drive for ships. This new system is of prime importance and value to our country, not only because it has resulted in placing our naval vessels and equipment in a highly satisfactory position of leadership, but because it has also pointed the way to the use of the electricity in propulsion of our merchant marine.

"I do not believe that it is possible to exaggerate the importance of the general introduction of electricity on ships of all kinds, including, as the final achievement, the operation of the driving machinery.

Emmet Given Credit

"It must be a great satisfaction to every man to remember that the modern steam turbine electric drive for ships largely resulted from the work of a graduate of our great naval academy at Annapolis, W. L. R. Emmet, who with a thorough understanding of the principles involved, attacked the problem and with patience and perseverance continued to overcome all obstacles until success was won. It is also a subject for congratulation that his efforts were only made successful as a result of the splendid co-operation and support which he received from the Navy Department presided over by its secretary, Mr. Daniels.

"The first advance, then, took place in the substitntion of the power of steam through the reciprocating engine for the blowing of wind upon the sails. This great event occurred, as stated, about a century ago, and the steam engine, with improvements, was our only source of mechanical power up to the last quarter of the 19th century, when the steam turbine made its appearance.

Steam Turbine Enters

"The application of the steam turbine to the driving of ships may be considered as an event only exceeded in importance by the original substitution of steam for sail power in such service. Unfortunately the full benefits of the steam turbine could not be realized because the turbine is inherently a very high-speed machine. While the propeller is best adapted to and is most efficient at relatively slow speed, however, the direct connection of the turbine to the propeller shaft was unquestionably the simplest and most rugged method and was naturally the plan first adapted. Unfortunately it demanded compromises in the design of both turbine and propeller which were only obtained by large sacrifices of efficiency in both.

"Therefore the constant search for improvement led to the introduction of reducing gear between the high speed turbine and the low speed propeller. While the improved efficiency which resulted marked another forward step, it was obtained at the expense of mechanical complications. Furthermore, it must not be forgotten that in both the direct turbine drive and in the turbine geared drive, the power available in reversing the direction of motion was greatly limited. That electricity could be used as a substitute for gears was perhaps obvious, but it was not obvious that it would be practical or economical. In fact, at first sight, it would seem both foolish and wasteful to resort to the double transformation of power involved, in first generating mechanical power from steam, converting this into electricity and then to reconvert the electricity back again into the mechanical power needed to drive the propellers. The correct and natural method seemed as stated, to be that originally followed in practice of applying the power produced by the turbine directly to the propeller, and afterwards to introduce the mechanical gears.

A Seeming Paradox

"That the electrical gear could by any possibility prove to be more generally efficient seems a paradox. What is the cause of the undoubted success of this paradoxical device? It is due, we believe, to the fact that in the electric drive an open air space is substituted for the teeth of the mechanical gear. Although we remove the teeth, we are able to transmit tremendous power without any mechanical connection. There is, in fact, no mechanical connection between the fixed and moving parts of the electric motors which may be regarded as the new electric gear, one which by its very nature, prevents the transmission of destructive shock or strain. The electrical method substitutes an indestructible, infinitely elastic air space for the teeth of the mechanical gear and obviously the air space cannot be bent, or broken, requires no lubrication and contains nothing to rub, or get out of order, the electric drive also permits of complete and instantaneous reversal of the direction of motion and thus enables the ship to move backwards under full power and add enormously to its ability to maneuver definitely and quickly."

Admiral Benson Assumes Full Responsibility for Board

Acting under the authority given by the President, Admiral Benson announces that he will assume full responsibility in administering the affairs of the Shipping Board, but that he will not attempt to adopt broad policies which would embarrass the new commissioners to be appointed. By this it is understood he will not attempt to settle such questions as revision of the sales prices, adoption of the bareboat charter plan, enforcement of section 28 or similar questions which can be deferred temporarily. He will exercise his power to decide on current issues, and especially will extend funds which are necessary for the operation of the Government fleet.

MERCHANT MARINE AS AN INTEGRAL PART OF SHIPPING SYSTEM FAVORED BY HOOVER

New Secretary of Commerce Denies that He Proposed to Recommend Acquisition of Shipping Board's Functions by His Department

America's railroad and steamship companies should be operated as a complete system, as an instrument of commercial operation and development in the opinion of Secretary Herbert Hoover, who recently announced his aims upon assuming direction of the Department of Commerce. Secretary Hoover pledged government aid to business and the development of foreign and domestic markets. It was the expressed opinion of the official that the Shipping Board should be separated from executive functioning and the steamship lines operated as an integral part of the transportation system. Secretary Hoover denied that he proposed to recommend the acquisition of the Shipping Board's functions by the Department of Commerce or the acquisition of the railway facilities by that department.

"If we would improve our national efficiency and our foreign trade," the secretary said, "we must consider our transportation, both railway, water and marine, as one system directed to serve the nation as a whole, the development of certain trade routes through the mercantile marine as the real extension of our inland transportation, the improvement of great waterways, opening of the Great Lakes to ocean going vessels, the development of great electrification to our power necessities and the handling of our labor readjustment by moderate men on both sides and of problems that have a fundamental bearing on our recovering in commerce and on our ability to compete."

Outlining his plans further, Mr. Hoover said:

"Outside of voluntary measures, the only immediate extension of service lies in securing greater internal efficiency, in which I am certain all the bureaus join. The future of the department in its ability to meet the needs of our industries and trade must await the thorough reorganization of the whole executive machinery, now being vigorously undertaken by Congress. The need of it, both in economy and to secure more definite purpose in Government department, does not need demonstration.

"The Department of Commerce," declared the Secretary, "should be in the widest sense a department of service to the commerce and industry of the country. It is not a department for the regulation of trade and industry. In order to do service to great advantage, I wish to establish a wider and better organized co-operation with the trades and commercial associations, and will in a short time present some plans to this end. I want to see our efforts to push our foreign commerce more closely related to our industries."

GROWTH OF ELECTRIC SHIP PROPULSION

The popularity and growth of the application of electricity for the propulsion of vessels, both naval vessels and merchant ships, is shown in the following table giving figures up to January 1, 1921:

Ship	Type	Horsepower	Speed, Knots	Tonnage Displacement
Naval Vessels				
In Service:				
Jupiter	Collier	7,000	15	20,000
New Mexico	Battleship	30,000	21	32,000
Tennessee	Battleship	30,000	21	33,000
Being Built:				
California	Battleship	30,000	21	33,000
Colorado	Battleship	30,000	21	33,000
Maryland	Battleship	30,000	21	33,000
Washington	Battleship	30,000	21	33,000
West Virginia	Battleship	30,000	21	33,000
Dakota	Battleship	60,000	23	43,000
Indiana	Battleship	60,000	23	43,000
Montana	Battleship	60,000	23	43,000
North Carolina	Battleship	60,000	23	43,000
Iowa	Battleship	60,000	23	43,000
Massachusetts	Battleship	60,000	23	43,000
Lexington	Battle Cruiser	180,000	33.6	43,500
Constellation	Battle Cruiser	180,000	33.6	43,500
Saratoga	Battle Cruiser	180,000	33.6	43,500
Ranger	Battle Cruiser	180,000	33.6	43,500
Constitution	Battle Cruiser	180,000	33.6	43,500
United States	Battle Cruiser	180,000	33.6	43,500
Merchant Ships				
In Service:				
Eclipse	Cargo Carrier	3,000	11	5,000
Cuba	Passenger and Cargo	3,000	17	2,126
Being Built:				
Eleven carriers	Each	30,000	11	5,000
Four coast guard cutters	Each	2,600	16	1,600

BOY SCOUT LAUNCHING

Swiftscout Takes Dip at Hands of Boys' Organization

The tanker *Swiftscout*, the fourth of seven 12,000 ton ships of this type to be built by the Northwest Bridge & Iron Company, Portland, Ore., for the Swiftsure Oil Transport Company, was turned over to boy scouts for launching on March 12, the ceremony being one of the most memorable in the history of Portland shipbuilding. The *Swiftscoutt* was originally intended to be named the "Swiftwind" but the name was changed in honor of the boy scouts' organization.

In thus renaming the vessel and turning her over to boy scouts the oil transport company and Cox & Stevens, naval architects, of 15 William Street, New York City, who are in charge of construction for this company, paid high tribute to the Boy Scouts of America for their service during the war and in times of peace. F. R. Mayer, president of the Swiftsure Oil Transport Company, in a telegram to Charles Desmond, local representative of Cox & Stevens, approved of the plan "as a hearty well wisher of the boy scouts' organization and a personal friend of Baden-Powell." Telegrams of commendation and congratulation were also received by Cox & Stevens from George L. Baker, mayor of Portland, and C. C. Colt, president of the Portland Council, Boy Scouts of America.

The three vessels remaining to be launched are expected to be completed early in June.

FEBRUARY TONNAGE

Bureau of Navigation Reports 111,609 Gross Tons

The Bureau of Navigation, Department of Commerce, reports ninety sailing, steam, gas and unrigged vessels of 111,609 gross tons built in the United States and officially numbered during the month of February, 1921. This total includes two rigged vessels of 140 tons and seven unrigged vessels of 914 gross tons, a total of nine vessels to 1,054 gross tons built in yearse previous to 1921. Five vessels of 42,311 gross tons were built for the United States Shipping Board.

Five vessels which are not included in this statement were built in this country for foreign owners during the month of February, 1921, and a total of twenty vessels of 3,408 gross tons were reported transferred to foreign flags during the same month.

From other sources than construction, two vessels of 346 gross tons were admitted to American Registry under the act of August 18, 1914.

Tyne Statistics

The number of ships launched from the Tyne in January, 1921, was eleven vessels of 28,054 net registered tons as against three vessels of 5,727 tons in January, 1920.

SHIP TRANSFERRED

"Wenatchee" Goes to Admiral Line for Japanese Service

The combination passenger and cargo ship *Wenatchee,* after a successful trial trip, has been transferred from the New York Shipbuilding Corporation to the United States Shipping Board, thence to the Pacific Steamship Company for Admiral Line service between Seattle, Wash., and Yokohama, Japan. The *Wenatchee* is a sister ship of the *Keystone State, Bay State,* and two other vessels not yet named, built and owned by the Government and allocated to the Admiral Line. The five vessels are known as "535's" (their length in feet), the beam measurement is 72 feet and their cargo capacity is 11,000 tons deadweight. The *Wenatchee* is propelled by two Westinghouse divided-flow turbines of 6,000 horsepower each and is equipped with Westinghouse condenser and steam auxiliaries.

The Admiral Line has announced its determination to establish and maintain a new American service in the face of all competition and is campaigning vigorously to obtain future American business, both passenger and freight, for these ships. The *Wenatchee* is in command of Captain J. E. Guptill.

Eagle Oil Tanker

The Standard Shipbuilding Corporation, Shooters Island, New York, has launched the third of four oil tankers contracted for the Eagle Oil Transport Company, Ltd., of London, England, the ship being christened the *Sun Ubaldo.* She is of 8,400 deadweight tons, 427 feet long, with extreme beam of 53 feet 5 inches, a molded depth of 31 feet and will have a speed of 11 knots.

CIVIL SERVICE COMMISSION TO FILL VACANCIES

The United States Civil Service Commission announces an open competitive examination for foundry helper, on April 27, 1921. A vacancy in the Bureau of Standard, Department of Commerce, Washington, D. C., and vacancies in positions requiring similar qualifications, at $720 to $1,080 a year, or higher or lower salaries, will be filled from this examination, unless it is found in the interest of the service to fill any vacancy by reinstatement, transfer, or promotion.

The commission also announces an open competitive examination for physical laboratory helper on April 13, May 25 and July 6, 1921, at all places in the United States at which city delivery mail service has been established. Vacancies in the Bureau of Standards, Department of Commerce, for duty in Washington, D. C., or elsewhere, at entrance salaries ranging from $600 to $900 a year, and in positions requiring similar qualifications, at these or higher or lower salaries, will be filled from this examination, unless it is found in the interest of the service to fill any vacancy by reinstatement, transfer or promotion.

FOREIGN YARDS CONTINUE TO SHOW ACTIVITIES IN THE CONSTRUCTION OF NEW SHIPS

Reports from China, France, Norway and Other Countries Reflect Favorable Tonnage Increases

According to the Shanghai Times, the shipbuilding industry during the year 1920 was very busy. The Shanghai Dock and Engineering Company launched and completed two large standard steamers for the British Government and launched six steel cargo vessels each of 300 tons deadweight capacity for local owners, and one steel twin-screw passenger and cargo steamer for the China Merchants Steam Navigation. They now have in hand two passenger and cargo steamers of about 340 feet long and one steel cargo hulk to carry 3,000 tons deadweight, and a twin screw Yangtze gunboat for the Italian Government.

The New Engineering Works had four large launchings last year and are now constructing two sea going cargo steamers for Norwegian owners. Important extensions and additions were made to the works to cope with the increased amount of work and many new machine tools of the most recent type were imported and installed.

The Kiangnan Dock Company launched two large standard steamers for the American Government and work is now proceeding on two others.

Labor in Shanghai has received several advances to meet the increased cost of living, but output has not suffered, and the yards are now in a much better condition for competing with other countries for the building and repair of ships.

Construction in France

The Chargeurs Reunis have now under construction in France, nine vessels all of which are to be fitted with refrigerating machinery. The Cie. Sud-Atlantique has two under construction and the Transports Maritimes a Vapeur also has two, all of which are to be fitted with refrigerating machinery. Before the war French owners had very few ships fitted with rferigerating appliances for freight, but now nearly all new cargo vessels being built are fitted with this arrangement.

Ateliers & Chantiers de la Loire launched on January 13 the steamship Baloue for the Chargeurs Reunis. This vessel is one of four sister ships specially built to run between France and the West Coast of Africa. They are 392 feet long, 7,500 tons deadweight, with one triple-expansion engine developing about 2,800 horepower. They have one 40-ton, one 20-ton, and eight 6-ton derricks.

Norwegian Building Increase

The Norwegian mercantile marine's net increase during the year 1920, was 123 ships of about 380,000 tons gross, the gross increase being 223 ships of 490,000 tons. These comprised 169 steamers of 430,000 tons and 50 motorships of 56,000 tons. About 60,000 tons were completed at Norwegian shipyards during the year 1920, as against 47,000 tons during the year 1919. There are at present building at Norwegian shipyards 87 boats with a tonnage of about 100,000, as against 117 boats of 107,000 tons in January 1920. The net increase in tonnage during the year was 22 percent. Christiania tonnage rose by 23 percent and Bergen tonnage by 30 percent.

Danes Also Busy

The Danish mercantile fleet's net increase during the year 1920, was 50 ships of 130,000 tons gross. The gross increase was 108 vessels of about 155,000 tons, out of which 62 were steamers of 120,000 tons and 26 motorships of 28,000 tons. About 60,000 tons were completed at Danish shipyards during the year 1920, as against 35,000 tons in the year 1919, and 146,000 tons are now under construction. The gross decrease amounted to 58 boats with a register of about 27,000 tons. The tonnage of the Danish Mercantile Marine increase during the year 1920, by about 16 percent.

Swedish Figures— head

According to Swedish Export, the Mercantile Marine of Sweden comprised a total of 2,817 vessels of 1,925,000 gross tons. Of this number 1,236 were steamships of 936,000 tons gross, 518 were motor vessels of 125,000 gross tons, and 1,063 were sailing vessels of 837,000 gross tons.

BUSINESS NOTES

The Marine Decking & Supply Company, W. L. Peebles, New York manager, announces the removing of its New York office from 3708 Woolworth Building to 44 Water Street. The company handles among other things litosilo decking composition, Madesco bituminous solution and enamel, and Madesco paints and varnishes.

Scott Brothers & Surtees, Inc., Consulting Engineers and Naval Architects, of 80 Broad Street, New York, announce that they have opened an office at 422 Whitney-Central Building, New Orleans, La., and are now in a position to undertake all kinds of work in connection with design, upkeep, survey and superintending of repairs on ships.

Co-operative Coal Agreement

A cooperative agreement has been effected between the Tidewater Coal Exchange, Inc., of New York and the United States Bureau of Mines for the classification of coal shipped for export through the ports of New York, Philadelphia and Baltimore on a basis of accurate sampling and analyses. The agreement provides for the establishment of limits and tolerances of quality for certain pools and for the maintenance of the quality of the pools within the limits specified.

Marine Construction News of the Month

Ship Contracts—New Ship Concerns and Shipyard Improvements—Terminal Projects—Government Contracts

SHIPS AND SHIPBUILDING

Barkentines, Victoria, B. C.—The Cholberg Shipyards are busy handling a contract for four barkentines, one of which, the S. F. Tolmie, is nearly ready for sea.

Marine Diesel Engines, Duluth, Minn.—It is reported that Alexander McDougall, president of the McDougall-Duluth Company, will shortly be in the market for a marine Diesel engine of about 1,100 horsepower.

May Buy Vessels, New York—The Baltic Steamship Corporation of America, 24 Whitehall Street, may purchase several desirable boats from the United States Shipping Board, according to current reports.

Lightship, Tenders, Etc., Morris Heights, N. Y.—The Consolidated Shipbuilding Company is building lightship 105 for the Bureau of Lighthouses, Washington, D. C., two lighthouse tenders, as well as two-steel vessels.

New Gears for Ship, Brooklyn, N. Y.—A contract for the installation of new Falk gears in the 8,800-ton Shipping Board vessel West Modus has been awarded to the Morse Dry Dock & Repair Company. The price was given as $19,000.

Steamer Damaged, Vancouver, B. C.—Wreck Commissioner McPherson has concluded his investigation in the wreck of the Canadian Pacific steamer Princess Beatrice, which is now in dry dock. The vessel is damaged to the extent of $30,000.

Hulls to Be Converted, Seattle, Wash.—It is reported that the forty wooden hulls built by the Emergency Fleet Corporation and now lying idle in Lake Union, near Seattle, may be converted into lightships, a scarcity of which exists on the Pacific Coast.

Vessel to Be Converted, San Diego, Cal.—It is announced that the Spreckles Bros. Company has purchased the hull of the kelp harvester, Point Loma, formerly operated by Swift & Company. The harvester will be converted into a coal barge and will be used for bunkering purposes at this port.

Overhauling Vessels, Seattle, Wash.—The Puget Sound steamer Aloha, which broke a crankshaft in Hood Canal recently, is undergoing repairs at the Todd Dry Docks on Harbor Island. The Aloha is operated by the Navy Yard Route, and another unit of this fleet is also undergoing overhaul at the same plant.

Overhauling Vessels, Hoboken, N. J.—Among the vessels being overhauled by the W. & A. Fletcher Company are the Baton Rouge, the Vistula and the Chinampa, three Standard Oil vessels. The French-American ship Ice King and United American ship Ipswich are also undergoing reconditioning at the Fletcher yard.

Repair Contract Awarded, Brooklyn, N. Y.—Theodore Crane & Sons, Erie Basin, has been awarded a contract for general repairs to the steamer West Galeta, a Shipping Board vessel, being operated by the Oriental Navigation Company. The price was announced as $5,800, and the work will probably be done at Pier 86, North River.

Construction Program Nearing End.—Of the 2,312 ships contracted for by the Shipping Board Emergency Fleet Corporation only one more keel is to be laid down before the active building program will come to an end. There are, however, fifty vessels of 407,412 gross tons under construction and yet to be delivered to the Government.

Repairs for Volunteer, New York.—The war emergency gears on the United States Shipping Board ship Volunteer will be replaced in the near future with a General Electric Company 2-plane gear, according to announcement this week. Superheaters to obtain 200 degrees of superheat will be installed and the turbine modified to meet those conditions.

Repairing Steamer, Brooklyn, New York.—The contract for repairing the Ocean Line steamer City of Columbus which struck on Lovellis Island recently has been awarded to the Robins Dry Dock and Repair Company, which was the lowest bidder. The vessel was floated last week and received some temporary patches to her bottom plates at Fore River.

Ferryboat Contract Let, Astoria, Ore.—The operation of an automobile ferry between Astoria, Ore., and McGowan, Washington, is now assured. A contract has been let to the Wilson Shipbuilding Company for the construction of a ferryboat to cost approximately $22,000. The craft is planned to accommodate fifteen automobiles and fifty passengers and will be ready for service May 15.

Tankers Building at San Pedro—According to word received from O. B. Kebel, works manager of the Southwestern Shipbuilding Company, the company's yard is building two 12,000 tankers for the Union Oil Company. It is also announced that the company has secured contracts for three large tankers to be constructed for the Anglo-Saxon Petroleum Company, which will sail under the Dutch flag.

Reboilering Steamers, Yonkers, N. Y.—The passenger steamer Nassau, of the Highlands Navigation Company, 17 State street, New York, recently left the dock of the New York Engineering Company, where a new Ludlum watertube boiler, 2,500 square feet heating surface, was installed. The passenger steamer Seagate is alongside the company's dock to receive a new Ludlum boiler of the same size as for the Nassau.

Electric Drive for Freighter, New York.—The contract for the installation of motors, generators and similar electric equipment in the American freight steamer Fordonia, of the American-Mediterranean Steamship Company, was awarded to the General Electric Company on March 3. The ship is also to have two Ansaldo internal-combustion engines, which will be installed by the Todd Shipyards Corporation.

Fireboats, New York.—A contract was recently awarded by the city of Philadelphia for a new fireboat to John W. Sullivan & Company, of New York. It will be a twin-screw, steel-vessel equipped along the most modern lines, and will probably be the largest fireboat on the Delaware River. The boat will cost $249,500, and is to be delivered by November 15. Bids for another fireboat for the city will be advertised for within a few days.

To Repair Yacht, San Pedro, Cal.—John D. Spreckles' yacht Venetia is at the yard of the Los Angeles Shipbuilding Company to undergo general repairs. The yacht is probably one of the best known in the country, having served in the war with Germany, and carries on its stack two gold stars, which tell the tale of two German submarines which the yacht sank, one of which was found to be the one responsible for the sinking of the Lusitania.

Remodel Steamers, Philadelphia, Pa.—The Ericsson Line steamers, Penn and Lord Baltimore, which have been tied up near St. George's for months, are to be remodeled and placed in operation on the route between Philadelphia and Baltimore, via the Chesapeake and Delaware Canal. It is said that the vessels will be cut down, remodeled and re-equipped before they are again placed in service. It is expected that oil burning systems will be installed in the vessels.

Ships for Peruvian Interests, San Francisco, Cal.—It is reported that with the completion of hull No. 10, now building at the yard of the Pacific Coast Shipbuilding Company, the yard will close down. Officials of the company are, however, considering a proposition made by wealthy Peruvian interests to move the majority of its equipment to Central America to handle a program for the construction of a number of ships of which the majority are believed to be war craft.

Steamer Repairs, Brooklyn, N. Y.—The contract for bottom repairs to the steamship Kaduna of the Elder-Dempster Line of Liverpool, England, which recently went ashore, has been awarded at Halifax, N. S., to James Shewan & Sons, Inc., Brooklyn, N. Y. The award was made on competitive bidding of Canadian and New York yards, the Shewan Company bid involving about $150,000. The work will occupy approximately thirty days, and the ship is now at the New York yard.

Steamers to Be Overhauled, Boston, Mass.—Early next month services of the Eastern Steamship Lines, Inc., Boston, Mass., will be resumed, and the steamers are now being overhauled and placed in readiness. The Calvin Austin and North Land will go on the Boston-New York route and the Camden and Belfast take their place on the Bangor division, the Governor Dingley will ply between Boston and St. John, and the Ransom B. Fuller is to be operated in the service to Portland, Me.

Repair Contract, San Francisco, Cal.—Bids for the work of repairing the steamer Alaskan, of the American-Hawaiian Steamship Company, which recently ran ashore at Asuncion Island, and was found to have thirty-eight plates dented on her forward hull, besides a number of frames and floors, were opened at San Francisco, Cal., recently, and it is announced that the Bethlehem Shipbuilding Corporation has been awarded the contract at a bid of $143,000. The Moore Shipbuilding Company came second with a bid of $150,000.

Reconditioning Steamer, New York.—Bids for the reconditioning of the Southern Pacific Company's freight and passenger ship Momus, which is to have new boilers and oil-burning equipment to replace the present coal-burning system, will probably be opened on April 7, according to announcement to-day. Superintending Engineer A. S. Hebble, of the Southern Pacific Company, arranged the plans and specifications, and Babcock & Wilcox boilers fitted with Babcock & Wilcox oil burners will be installed.

Moore Yard Activities, Oakland, Cal.—The Moore Shipbuilding Company is building three Shipping Board tankers of 10,000 tons each, and two freighters for the Matson Navigation Company, each of 14,500 tons, which were recently launched. Hull 166, another 10,000-ton tanker for the Vacuum Oil Company, of New York, is on its way to completion. The H. T. Harper, a motorship of 4,750 tons, being built for the Standard Oil Company, is to have Diesel engines made by the Skandia Pacific Oil Engine Company.

To Purchase Steamers, Los Angeles, Cal.—It is reported that Los Angeles shipping interests are seeking to procure by purchase from the Government five of the new type combined passenger and freight steamers to operate in the Pacific, with San Pedro as their home port. At a hearing before the Los Angeles Chamber of Commerce it was suggested that the ships be sold on an agreed price of $5,000,000. It is said that the representative appearing before the board was backed by the Duke Tobacco Company interests.

Dry Dock Section Floated.—The first instalment of the floating sectional dry dock, to consist of eleven pontoons, and which is to cost $1,500,000, was sent into the Delaware River, recently, by the Sun Shipbuilding Company, Chester, Pa. The pontoon was towed to the wet dock, where it will be moored until other sections of the kind arrive and the steel superstructure is begun that will finally bind the eleven parts together in a single unit. It is expected that the drydock will be completed and in operation by this summer.

Iceboat.—The New Jersey Legislature has approved the plan and has appropriated $50,000 for the purchase and operation of an iceboat on the upper Delaware River between Philadelphia and Trenton, to eliminate the ice blockades which interfere with the shipbuilding activities. A similar measure has been introduced in the Pennsylvania Legislature, and Mayor Moore, of Philadelphia, has forwarded to Governor Sproul a communication from Mayor Donnelly, of Trenton, favoring the appointment of a joint commission for the purchase of this boat.

Fireboat, Shooters Island, N. Y.—The contract for a new fireboat for the city of New York, for which bids were opened on February 14, was awarded on Tuesday, March 8, to the Standard Shipbuilding Corporation, on a bid of $222,000. The vessel is to be 132 feet in length, equipped with compound engines, 18 inches by 38 inches by 26 inches, and will have two turbine-driven fire pumps. Work will be started immediately, to be completed in 245 days. The plans and specifications were prepared by J. W. Millard & Bro., naval architects, 17 State Street, New York.

Barge, Etc., Baltimore, Md.—Contract for a 350-ton self-propelled oil barge for the Standard Oil Company of New Jersey, 26 Broadway, New York, has been awarded to the Baltimore Dry Docks & Shipbuilding Company. The boat is to be 130 feet in length, the motive power to consist of two gasoline or kerosene engines developing from 350 to 400 horsepower.

New bids will probably be called for in the near future by the Standard Oil Company for two 48-foot motor-driven craft to be used as dispatch boats in New York harbor. Bids on these two boats were opened last week, but were rejected.

Dry Dock.—The first section of a new 11,000 gross ton dry dock, being built for Theodore Crane & Sons' yard, was launched yesterday at Erie Basin, Brooklyn, N. Y. When all four sections of the dock have been joined together it will be able to accommodate vessels 500 feet long. The dock will be one of the most modern in existence and the third largest in the port of New York. It is electrically driven and operated by one-man control on the pier at the head of the dock. The dock, which is being built by the Crane Company itself, has centrifugal pumps, motor driven, and is expected to be ready for operation by October 1.

Repairing Schooners and Building New Craft, Seattle, Wash.—One of the most active plants on the waterfront, is the marine ways of the Elliott Bay Marine Construction Company, C. O. Morrow, general manager, where many units of the local mosquito fleet are being overhauled and repaired for the coming fishing season. The Fanny Dutart, one of the largest schooners of the fleet, is being practically rebuilt, her house, decks and other items are being replaced. Several other vessels, including the Cherry, Elizabeth and Imperial, are also undergoing repairs at the plant. The construction of several small craft is also being undertaken.

Diesel Electric Drive, New York.—The 8,800-ton Shipping Board ship West Zaca is to be fitted with Diesel electric drive according to official information obtained by MARINE ENGINEERING. While no specific time for the completion of specifications and the opening of bids has been set, it is believed the work will be undertaken in the near future and will involve approximately $100,000. Plans and specifications will be completed shortly for making the 12,000-ton Shipping Board steamers Independence and Victorious into electric-drive vessels, bids for which are to be opened in a few weeks. These two contracts will probably involve about $150,000.

Los Angeles Shipyard Busy, San Pedro, Cal.—The West Lewark, an 11,600-ton cargo carrier being built for the Emergency Fleet Corporation, has been launched by the Los Angeles Shipbuilding & Dry Dock Company. Four freighters of the West Lewark class are now in various stages of construction at this yard. Their overall length is 444 feet, beam molded 54 feet, draft with design loaded 28 feet 2 inches.

The same yard has for reconditioning the Union Oil Company's 12,000-ton tanker Los Angeles and the steamships Yale and Harvard, the latter two having done transport service between England and France during the war.

To Rebuild Motorship.—Bids for the rebuilding of the motorship Trolltind, of the Anglo-Norwegian Shipping Corporation, which was recently extensively damaged by fire at Newport News, Va., were opened on Monday last, at the office of Walter Thompson, marine surveyor, 1 Broadway, New York, with the following results: New York Harbor Dry Dock Corporation, Fort Jefferson, N. Y., $108,200 (58 days); Tietjen & Lang Dry Dock & Repair Co., Hoboken, N. J., $108,807 (66 days); Theo. Crane & Sons Co., Brooklyn, N. Y., $101,357 (75 days); Robins Dry Dock & Repair Co., Brooklyn, N. Y., $114,600 (70 days); Baltimore Dry Docks & Shipbuilding Co., Baltimore, Md., $171,900 (120 days). No announcement was made of the awarding of the contract.

Ferryboats, New York.—Plans and specifications will soon be under way for three 225-foot ferryboats for service to Staten Island, construction of which was assured by the decision on March 21 of the Board of Estimate Committee on Financing Budget to make a favorable report to the board, on Plant & Structures Commissioner Grover A. Whalen's application for $1,560,000 in corporate stock with which to establish a new service to Stapleton. Following the announcement by MARINE ENGINEERING on February 12 of the proposed three boats, it was learned that bids for their construction will probably be advertised for in July, contract award to be made about August 1, with probable delivery of the boats next March. Tentative plans at present call for the synchronous type of motors, watertube boilers producing 250 pounds working pressure, Curtiss turbines, superheaters, and boilers fitted for coal or oil consumption. Of the funds approved, $200,000 will be used for construction of slips and racks at Stapleton, plans for which are now under way.

PORT IMPROVEMENTS

Docks, Jacksonville, Fla.—The city has voted $1,000,000 bonds for the extension of municipal docks. John S. Bond is chairman of the City Commission.

Wharf, Pascagoula, Miss.—The city has voted $15,000 bonds for wharf construction and equipment. Address the mayor.

Winches, New York.—The city will soon be in the market for about seventy-four drum type winches for its municipal docks.

Cranes, New York.—It is reported that W. R. Grace & Company, 7 Hanover Square, has asked for bids on several small capacity locomotive cranes ranging from 3-ton to 7-ton capacity.

Wharf, Graham Landing, B. C.—The Department of Public Works, Ottawa, Canada, has let a contract for building a public floating wharf to L. H. Rawlins, Nakuska; to cost $23,852.

Wharves, Royston, B. C.—The Department of Public Works, Ottawa, Canada, has let a contract for building the wharves to W. Greenless, 407 Cordova Street, W., Vancouver, B. C.; $14,774.

Harbor Works, Venezuela.—The Government plans the construction of port and harbor works at Ocumare de la Costa, as well as an electric railroad across the range between that port and Maracay.

Dredging, Oakland, Cal.—The United States Engineer let a contract for dredging the harbor, First District, to the American Dredging Company, 255 California avenue, San Francisco, Cal., to cost $101,700.

Dredging, Galveston, Tex.—The United States Engineer let contract for dredging the Houston ship channel to the Atlantic, Gulf & Pacific Company, 21 Park Row, New York, involving an expenditure of $358,440.

Pier, Etc., Portland, Me.—Fay, Spofford & Thorndyke, engineers, 15 Beacon Street, Boston, Mass., are preparing preliminary plans for constructing a pier, pier sheds and dredging of shipways, involving the expenditure of about $1,250,000.

Freight-Handling Equipment, New York.—Murray Hurlburt, Commissioner of Docks, Pier A, North River, has rejected bids received February 10 for furnishing and installing freight-handling equipment at the foot of East Fifty-first Street, East River. New bids will be called for.

Bulkhead, Baltimore, Md.—The Department of Public Improvements, William F. Broening, president, Board of Awards, Baltimore, Md., let contract to Dorsey & Miller, Equitable building, Baltimore, at $10,991.48, to construct bulkhead in front of Center Pier, Back Basin. Bancroft Hill is harbor engineer, and H. C. Perring is chief engineer.

Ship Terminal, New Jersey.—The State Board of Commerce and Navigation, Trenton, N. J., has approved the lease of 1,622 lineal feet of bulkheads along the Hudson River to the Luckenbach Terminal Company of Bulls Ferry, at an annual rental of $87,500. A great ship terminal will be constructed on the property by this company, which operates steamers in all parts of the world.

Pier, Arica, Chile.—It is reported that the Chilean government has appropriated the sum of $340,000 for the beginning of construction work upon the new pier at Arica. Construction will be similar to that of the several piers now existing with piling of steel tubes connected with steel rod braces and a flooring of timber. A number of steel cranes of from 20 to 50 tons capacity will be required.

Docks, Windsor, Ont.—According to recent reports, the Detroit & Windsor Ferry Company, 2 Woodward Avenue, Detroit, Mich., will build two docks at the foot of Ouelette and Ferry Streets, at a cost of about $500,000, and in addition will put on a new ferryboat with accommodation for sixty automobiles on the main deck and 2,500 passengers on the upper deck. The dimensions of the new ferryboat are given as follows: Length, 175 feet, with an additional 10 feet in width over the company's other boat, the Britannia.

Dredging Contracts, New York.—The Bridgeport Dredge & Dock Company, Bridgeport, Conn., is announced as the successful bidder for three government contracts in the Hudson river, for which bids were received in New York on March 1. The work consists of re-dredging the harbor channels at Tarrytown, Peekskill and Wappinger Creek, N. Y.

The company has also obtained a contract from the Ingersoll Engineering & Construction Company for dredging in Johnston's Creek,

Bridgeport, to provide sufficient channel depth for the operation of ferryboats in connection with the amusement park at Steeplechase Island. Total approximately $50,000.

GOVERNMENT WORK

Canal.—The United States Government, Washington, D. C., plans to build a commercial canal from the Ohio river to Lake Erie, to cost about $25,000.

Quay Wall, Pearl Harbor, H. T.—Specification 4,360, the Bureau of Yards and Docks, Navy Department, Washington, D. C., is receiving bids for building a quay wall.

Pier, Hampton Roads, Va.—Specification 4399, the Bureau of Yards and Docks, Washington, D. C., plans to construct a speed boat pier at the Naval Operating Base.

Riprapping, Mare Island, Cal.—Specification 4390, the Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to riprap Dike 12. This is a large contract.

Electric Light and Power System, Quantico, Va.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to install an electric light and power system.

Crane and Crane Runway, Brooklyn, N. Y.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., will install a new crane and crane runway at the Brooklyn Navy Yard.

Hoisting Plant, Panama, C. Z.—A. L. Flint, purchasing officer, Panama Canal, Washington, D. C., will receive bids until April 4, for the purchase of a hoisting plant for the Panama Canal.

Reciprocating Air Compressor.—Specification 4,327, the Bureau of Yards and Docks, Navy Department, Washington, D. C., is receiving bids for installing a reciprocating air compressor at Bellevue.

Steel Buildings, Pearl Harbor, T. H.—Specification 4404, the Bureau of Yards and Docks, Navy Department, Washington, D. C., will receive bids until May 11 for constructing steel buildings.

Electric Traveling Crane, Puget Sound, Wash.—Specification 4392, the Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to construct an electric traveling crane at the timber storehouse.

Dredging, Providence, R. I.—The United States Engineer Office will receive bids until April 1 for maintenance dredging in the Connecticut River below Hartford. Further information will be furnished on application.

Electric Hoisting Equipment, Lakehurst, N. J.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to install electric hoisting equipment, as well as an electrically operated platform at the new aircraft plant.

Electric Distributing System, Pearl Harbor, H. T.—Specification 4401, the Bureau of Yards and Docks, Navy Department, Washington, will receive bids until May 11 for constructing an electric distribution system at the Naval Station.

Derrick Boats, Louisville, Ky.—The United States Engineer Office, Box 72, will receive bids until April 7, for furnishing and delivering three steel derrick boats for Lock and Dam 45, Ohio River. Further information will be given on application.

Dredging, Norfolk, Va.—The United States Engineer Office, War Department, Washington, D. C., has let a contract for dredging the 40-foot channel harbor to Sanford & Brooks Company, Commercial and Water Streets, Baltimore, Md., at a price of $130,500.

Hopper Dump Scows, New York City.—The United States Engineer Office, Room 710, Army Building, 39 Whitehall Street, will receive bids until 12 M., April 11, for constructing and delivering three 1,000 cubic yards wooden hopper dump scows. Further information given on application.

Coal Bids Rejected.—The Shipping Board has for the third time rejected bids for approximately 2,000,000 tons of bunker coal for twelve months' requirements on the Atlantic and Gulf coasts. The most recent offers ranged from $5.96 to $10.50 a ton, depending on the condition of delivery.

Wire Rope, Etc.—The United States Shipping Board, Washington, D. C., will receive bids until April 22 for furnishing wire ropes and hawsers for its ships for three months from May 10. These supplies are to be delivered at Boston, New York, Philadelphia, Baltimore, Norfolk, Charleston, Savannah, Jacksonville, Mobile, New Orleans and Galveston.

Equipment for Coal-Handling Plant, Mobile, Ala.—The water-front site donated by citizens for the construction of a new coal-handling plant for Mississippi-Warrior river service, has been taken over by the War Department, and will be built under the direction of that department. It will include a tipple with loading and unloading machinery, conveying equipment, etc., and is estimated to cost about $400,000.

Oil Bunkering Station, Blakely Island, Ala.—According to an announcement by the Shipping Board, a fuel oil bunkering station will be erected on Blakely Island about a mile and a half north of Mobile. Bids for the construction of this station will be received until March 30 at the office of the district purchasing agent at New Orleans, La. The Board will furnish fabricated material for the tanks, separate bids for which have already been requested.

Naval Vessels to Be Overhauled, Puget Sound, Wash.—The U. S. S.S. Frederick, flagship of the Pacific fleet's convoy ships, will be thoroughly overhauled at the Puget Sound Navy Yard, where she will be laid up for thirty days, having arrived in port after an absence of four years. The Idaho, the Mississippi, New Mexico and possibly the Tennessee, the latter warship now being on the Atlantic Coast, will all undergo repairs at the Puget Sound yard, and will be in port all spring.

Navy Yard Improvements, Charleston, S. C.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., is receiving bids for an extension to be made to berth 314, at the Navy Yard. An appropriation of $190,000 is available for the proposed work. The extension is to be 405 feet long and 59 feet wide, bringing the total length of the pier to approximately 800 feet. This berth is situated on the north side of the drydock and is used principally for repair work. The work of renovating and improving the power plant at a cost of $88,000 is to begin at an early date.

Bids for Ship Paint.—The United States Shipping Board, Purchasing Department, Division of Supply and Sales, Washington, D. C., will receive bids until 2 P. M., April 15, for furnishing such quantities of ship bottom paints as may be required for the period of six months, beginning May 15, for the following ports: New York; Portland, Me.; Boston, Mass.; Providence, R. I.; Portsmouth, N. H.; Baltimore, Md.; Norfolk, Va.; Newport News, Va.; Charleston, S. C.; Savannah, Ga.; Jacksonville, Tampa, Pensacola, Fla.; Mobile, Ala.; New Orleans, La.; Galveston, Tex.; San Pedro, Cal.; San Francisco, Mare Island, Oakland, Alameda, Cal.; Portland, Ore.; Seattle, Wash., and Philadelphia, Pa., except William Cramp & Sons Ship & Engine Building Company. The estimated expenditure involved, including the application of paint at the port of New York only, will be about $1,400,000.

FOREIGN ACTIVITIES

Another Contract Lost to England—A Portsmouth ship repairing concern has lost the contract for repair of the White Star steamer Arabic, which amounted to £100,000, or $400,000, to a firm in Cherbourg, France.

New Shipyard Planned, Italy.—A group of Italian banks have provided 66,000,000 lire for construction of a great trade and industrial port at Vade, in the Province of Liguria. The plans have been drawn up by Ricardo Negri, engineer. In connection, at the mouth of the Quilliane River, a shipyard will be established.

Capital Ships, England—According to Sir James Craig, parliamentary and Financial Secretary to the Admiralty, in his announcement in the House of Commons recently, four capital warships of the Hood class will be laid down within a year. The Hood is a battle cruiser of 41,200 tons normal displacement and 44,000 tons with a full load.

Largest Ship for the I. M. M., England.—The former German liner Bismarck, the largest ship in the world, recently purchased by the White Star Line from the British Government, will be renamed the Majestic. She is of 56,000 tons, and is now being made ready for her new owners by German workmen in the Hamburg yards. When completed the vessel will accommodate 3,500 passengers.

Liner for Dutch, Belfast, Ire.—The new 32,000 gross ton passenger liner building at the Harland & Wolff yard, Belfast, for the Holland-America Line, will be equipped with Diesel engines, which are expected to develop 17 or 18 knots. The ship will be named the Statendam, and will be ready within two years. She will be about 800 feet long and have accommodations for about 3,000 passengers.

Port Depelopments on Danube.—The Minister of Commerce, Dr. Hotopetz, made large contracts, while in London, for building four Danube ports. Bratisalvé, the largest with three general docks, will be capable of receiving 5,000,000 tons and be fitted with an elevator costing 40,000,000 kronen. The second port of Komorn will be capable of taking 1,000,000 tons. Other ports are to be erected at Parkangnana and Theben.

LAUNCHINGS

Conte Rosso.—Messrs. William Beardmore & Company, Ltd., have launched at the Naval Construction Works, Dalmuir, the Conto Rosso, the first of two ships under construction to the order of Lloyd Sabaudo, Genoa, Italy, for their passenger and cargo service between Italy and South America. The vessel is 591 feet over all length, and of 18,000 gross tonnage. The propelling machinery, which is supplied by the builders, consists of two sets of Parsons combined turbines, each set comprising one high-pressure and one low-pressure turbine and having an astern turbine incorporated in each low-pressure casing. Steam is supplied by six double-ended and two single-ended boilers fitted primarily to burn-oil fuel, but which can be readily converted for the burning of coal.

El Ghazi.—The London & Montrose Shipbuilding & Repairing Company, Ltd., has launched the steel motor-coasting vessel El Ghazi, which they have built to the order of A. Besse, Esq., of Aden, per Messrs. J. Stoner & Company, of London.

The dimensions of the vessel are 132 feet by 25 feet by 12 feet 6 inches molded, and the propelling machinery is designed to give a speed of nine knots, consisting of a set of single screw "Beardmore" oil engines of 200 brake horsepower and in addition to the main engine an auxiliary set of machinery is fitted consisting of air compressor, general service pump and dynamo. The dynamo generates current for the electric lighting installation and for driving two powerful cargo winches and a windlass. The machinery is supplied by Messrs. William Beardmore & Company, Limited, Coatbridge.

NEW INCORPORATIONS

A. B. & C. Shipping Company, Inc., Dover, Del., has been incorporated with a capital of $1,000,000 to build, own and operate boats.

Marine Oil Company Dover, Del., has been incorporated with a capital of $1,000,000, for transportation of oil coal, lumber, etc.

Exchange Steamship Company, Wilmington, Del., has been incorporated with a capital of $100,000 to build, own and operate boats.

Union Maritime Company; Boston, Mass., has been incorporated with a capital of $250,000; watercraft of all kinds.

Central Steamship & Commerce Company, Wilmington Del., has been incorporated with a capital of $1,000,000 to build, own and operate boats.

The 'Barge & Packet Navigation Company, Manhattan, has been incorporated with a capital of $500,000, by J. H. Clark, Jr., D. A. 'Esperance, Jr., C. E. Buckner.

The Florida Terminal Company, Ocala, Fla., has been incorporated with a capital of $1,000,000, by Clarence and Jack Camp, Ocala, and G. F. Armstrong, Savannah, Ga.

Halschaw Steamship Lines, Equitable Building, Baltimore, Md., has been incorporated with a capital of $300,000, by James L. Watson, Ferdinand H. Butchorn, Thomas E. Halle.

Industrial Development Company. Houston, Texas ship channel industries, has been incorporated with a capital of $50,000, by Paul Wipprecht, E. O. Kruger, and J. Campbell.

Jacksonville Coal & Dock Co., water and maritime rights, $350,000; T. L. Croteau, M. A. Bruce, S. E. Dill, Wilmington.

Metropolitan Securities Corporation, New York, has been incorporated with a capital of $50,000, by Lawrence N. Martin Patrick J. Dolson, and William Shea to build and operate boats.

National Mercantile Marine, 3 East Lexington Street, Baltimore, Md., has been incorporated with a capital of $100,000, by Frederick W. Flottwell, Frank E. Welsh, Jr., and Harold Lee, to carry on a transportation business.

The North & South Line, Inc., Wilmington, Del., has been incorporated with a capital of $10,000 to establish and maintain line of service of steamships; T. L. Croteau, M. A. Bruce, and S. E. Dill, incorporators.

Overseas Salvors, Inc., has been incorporated with a capital of $600,000 to engage in ocean commerce; John W. Crandall, E. M. Potter, and I. W. Bonner, New York, incorporators.

The Fred E. Jones Dredging Company, Norfolk, Va., has been incorporated with a capital of $250,000.

B. H. Elliott, Inc., Houston, Tex., has been organized with a capital of $20,000, by Don Hall B. H. Elliott and W. P. Buckley to operate a shipbuilding and repair plant.

United States Salvage Association, Manhattan, marine surveying, etc., 2,000 shares common stock, no par value; active capital, $10,000; L. F. Burke, W. W. Parsons, E. C. Jameson, 9 East 69th St.

Hunts Point Iron Works, Bronx, $10,000; Kopelson, G. and E. Lippert, 2555 3d Ave., Bronx.

Navigation Paint Co., Manhattan, marine painting, $5,000; M. E. Graef, E. Light, M. Erenstoft, 65 Lenox Ave.

Deep Water Salvage & Drydock Co., Seattle, Wash.; capital $1,000,000.

TRADE PUBLICATIONS

Multiscreen Filter.—The construction of a multiscreen filter, designed to remove oil, grease and other foreign matter from condensed steam is described in a pamphlet published by the Griscom-Russell Company, 90 West Street, New York. Tables of capacities and examples of typical installations in steam lines are included.

Equipment Bulletins.—Interesting literature, combined in complete sets of bulletins on automatic-steam engines, steam-pumping machinery, high efficiency power pumps, steam turbines and centrifugal pumps, water-wheel equipment, oil-mill machinery, oil-burning equipment, etc., is being offered by Charles F. Ames & Company, Ltd., hydraulic and contract engineers, 90 West Street, New York City.

Life Saving Equipment.—Two folders, giving the details of Welin quadrant davits and Lundin deck lifeboats, have been issued by the American Balsa Company, 50 East 42nd Street, New York. Other types of life-saving equipments also briefly described, including semi-decked lifeboats, collapsible lifeboats, life rafts, sheath-screw davits, Balsa wood insulation for refrigerators and accessories for all this equipment.

Safety Starting Switch.—A small folder published by the Cutler-Hammer Manufacturing Company, Milwaukee, Wis., describes and illustrates a safety-starting switch for alternating-current motors of squirrel-cage type. The folder states that this switch protects the motor by inserting the fuses in circuit only after the motor has reached speed. When the switch is off and the fuses are dead a heavy panel on the inclosing case may be lowered to allow inspection and the renewal of fuses.

"Steering You Straight."—Construction and operation of the Benson electric telemotor are outlined in a catalogue recently issued by the Benson Electric Company, Superior, Wis. This telemotor is designed to perform the function of steering on the "follow up" principle and consists essentially of three units, a master controller, a set of relays and the telemotor proper. When the handle of the master or the auxiliary controller is moved out of the midship position electromagnetic relays are excited. The movement of the relays closes an electrical circuit with the telemotor which is connected to the steam-steering engine valve and causes the proper movement of the rudder. A series of letters giving examples of operating records with the Benson telemotor are also published in this book.

Needless Ruin.—A fire protection system specially efficient on oil-burning vessels and tankers where the hazard is great is described in a pamphlet issued by the Foamite Firefoam Company, 200 Fifth Avenue, New York. This system for extinguishing fires consists of smothering a blaze by means of a blanket of carbon dioxide bubbles which may be sprayed from a sprinkler system, extinguishing engines or hand sprinklers. Instances of the use of various types of apparatus utilizing this means of protection aboardship are given. In connection with these, the details of the Fire Detecting Wire System for locating incipient fires are described. It is claimed that the two systems working together for detecting and extinguishing fires form one of the most efficient methods of ship protection against fire.

Habirshaw Manual.—The Habirshaw Electric Cable Company of Yonkers, N. Y., through its engineering field service, is making investigation of the requirements and practice of the wiring of ships. This investigation is based upon the application of the requirements of the marine code, which was formulated in 1920, by the Marine Committee of the American Institute of Electrical Engineers. This work is enabling the company to prepare a manual on marine wires, based on the above mentioned code, which would be similar in arrangement to the Habirshaw manual issued some time ago. This manual on marine wires will appear serially in the advertising pages of MARINE ENGINEERING. By clipping these advertisements and preserving them in some suitable form, readers will eventually have a complete manual on marine wires and cables.

MARINE SOCIETIES

AMERICA

AMERICAN SOCIETY OF NAVAL ENGINEERS

Navy Department, Washington, D. C.

President—Capt. A. J. Hepburn, U. S. N.
Secretary-Treasurer—Commander J. S. Evans, U. S. N., Bureau of Engineering, Navy Department, Washington, D. C.

Annual meeting and election, first Tuesday in October, other meetings at call of the President.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS

29 West 39th Street, New York.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS

29 West 39th Street, New York City.

UNITED STATES NAVAL INSTITUTE

Naval Academy, Annapolis, Md.

President—Rear Admiral Bradley A. Fiske, U. S. N.
Secretary and Treasurer—Commander H. K. Hewitt, U. S. N.

NATIONAL ASSOCIATION OF MASTERS, MATES AND PILOTS

National President—John H. Pruett, 423 Forty-ninth St., Brooklyn, N. Y.
National Treasurer—A. B. Devlin, 187 Randolph Ave., Jersey City, N. J.
National Secretary—M. D. Tenniswood, 308 Vine St., Camden, N. J.

LIST OF OFFICERS, AMERICAN SOCIETY OF MARINE DRAFTSMEN

President—C. E. Deiser, 6124 Nassau Road, Philadelphia, Pa.
Vice-President—E. H. Monroe, 902 Virginia Ave., Washington, D. C.
Secretary—B. G. Barnes, 970 High St., Bath, Maine.
Treasurer—J. B. Sadler, P. O. Box 987, Norfolk, Va.
Executive Committeemen—G. W. Nusbaum, Washington, D. C.; A. H. Haag, Narberth, Pa.; John Thomson, Bethlehem, Pa.

NATIONAL MARINE ENGINEERS' BENEFICIAL ASSOCIATION OFFICERS

National President—Wm. S. Brown, 356 Ellicott Square Bldg., Buffalo, N. Y.
National Secretary-Treasurer—Geo. A. Grubb, 356 Ellicott Square Bldg., Buffalo, N. Y.

ATLANTIC COAST SHIPBUILDERS' ASSOCIATION

1701 Walnut Street, Philadelphia, Pa.

Secretary—C. S. King.

AMERICAN STEAMSHIP OWNERS' ASSOCIATION

17 Battery Place, New York

Vice-President and General Manager—Winthrop L. Marvin.

AMERICAN STEAMSHIP OPERATORS' ASSOCIATION

17 Battery Place, New York

CANADA

GRAND COUNCIL, N. A. OF M. E. OF CANADA

Grand President—E. Read, Rooms 10-12, Jones Building, Vancouver, B. C.
Grand Vice-President—Jeffrey Roe, Levis, P. Q.
Grand Secretary-Treasurer—Neil J. Morrison, Box 886, St. John, N. B.
Grand Conductor—E. A. House, Box 333, Midland, Ont.
Grand Door Keeper—Lemuel Winchester, 306 Fitzroy Street, Charlottetown, P. E. I.

GREAT BRITAIN

INSTITUTION OF NAVAL ARCHITECTS

5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

39 Elmbank Crescent, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORPORATED

The Minories, Tower Hill, London.

ITALY

COLLEGIO DEGLI INGEGNERI NAVAL E MECCANICI IN ITALIA,

Via Carlo Alberto 18, Genova.

Marine Engineering

Volume XXVI MAY, 1921 Number 5

MAY 5 1921 U. S. PATENT OFFICE

Fig. 1.—S.S. *Oropesa*, from an Original Painting by Arthur J. W. Burgess, R. I.

Passenger and Cargo Steamer Oropesa

New Twin Screw Vessel Added to the Fleet of The Pacific Steam Navigation Company

THE large passenger and freight vessel *Oropesa*, recently placed in the New York, Cherbourg, Southampton service, by the Pacific Steam Navigation Company, is a beautiful example of modern practice for vessels of this type.

Constructed at the shipbuilding yard of Messrs. Cammell Laird and Company, Ltd., at Birkenhead, England, the *Oropesa* was launched December 9th of last year.

Principal Dimensions

Designed for a displacement of 24,000 tons and a sea speed of 14½ knots, the vessel is of the following dimensions:

Length	552 feet
Breadth molded	66 feet
Depth molded to shelter deck	45 feet
Gross tonnage	14,500 tons

The vessel is built of steel under special survey for Lloyds 100 A-1 class, with Board of Trade Certificate for the carrying of passengers and fulfills the requirements of the Spanish Emigration Law and the International Convention requirements for passenger vessels.

Passenger Accommodations

Of particular interest is the manner in which the accommodations for passengers have been arranged and the elaborate decorations and furnishings provided, every comfort and luxury being cared for.

Accommodation for 143 first class, 131 second class and 366 third class passengers is provided, making a total of 640.

First Class

Situated at the fore end of the bridge deck is the first class lounge and music room, a spacious room with raised ceiling and finely panelled sides.

The furniture is of polished mahogany, arranged to give a cosy effect, and the floor is laid with suitable Rublino tiles.

Fig. 2.—First Class Dining Saloon

Fig. 3.—Second Class Double or Four-Berth Cabin

Fig. 4.—First Class Social Room

Fig. 5.—Second Class Social Room

NUMERALS

L(B+D) 530'-0"×103'	54590
B+D 66'-0"+37'	103
d to Main Dk. 29-(4'-2")	24'-10"
" " Lower " 24'-10"-(8'-0")	16'-10

EQUIPMENT NUMERAL

L×(B+D) to Upper Deck	54590
Upper Deck to Shelter Deck	3180
Remainder	3902
Total	61672

Nearest Numerals 60600 – 63800

EQUIPMENT

Anchors - 2 Bower Stockless	113 Cwts each
1 " "	97 " "
1 Stream Ex. Stock	34 " "
1 Kldge " "	18 " "
Cable - 330 Fathoms of 2 15/16" Stud Link	1440 "
Stream 150 " " 1 9/16" " "	215.5 "
Tow Line 130 " " 7" Steel Wire	

Hawsers & Warps 4 Lengths of 3" Steel Wire 120 Fathoms each
4 " " 8" Manilla 120 Fathoms each

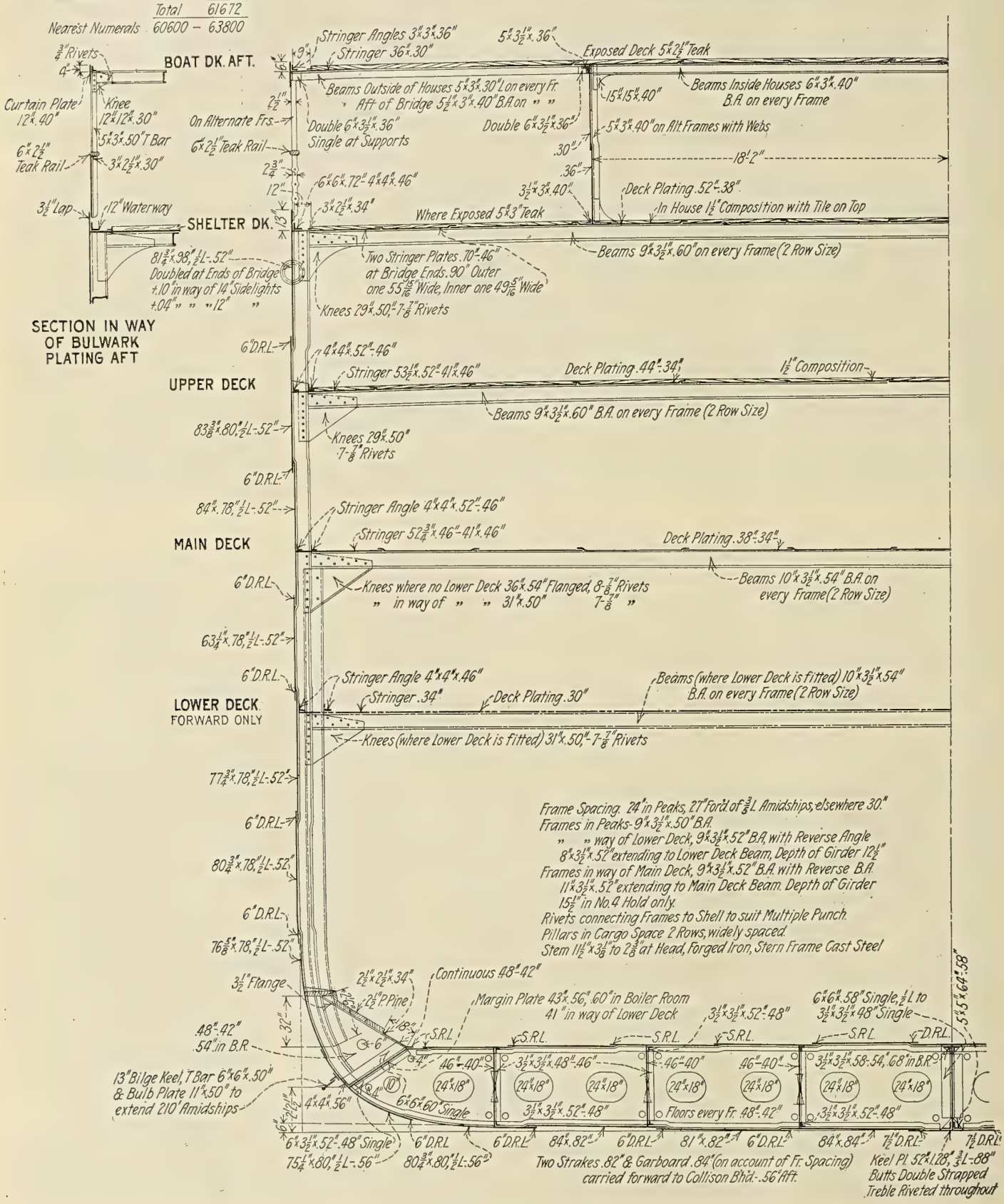


Fig. 6.—Section in Way of Hold

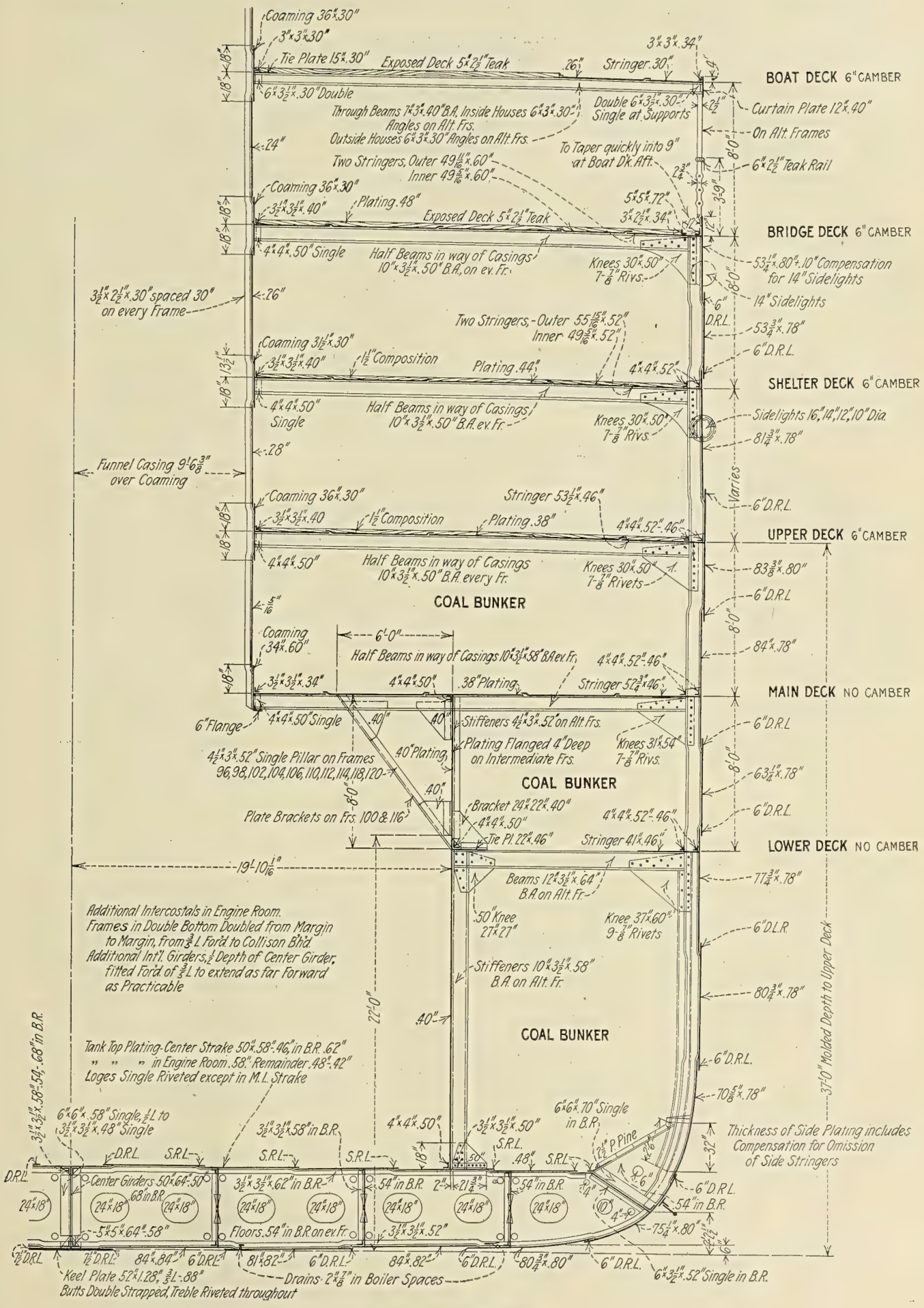


Fig. 7.—Midship Section

Passenger and Cargo Steamer Oropesa

General Information

Service: Passenger and Freight, New York, Cherbourg, Southampton.

Builder: Cammell Laird & Co., Ltd., Birkenhead, England.

Owner: Pacific Steam Navigation Company, London, England.

Characteristics

Length, overall	552′-0″
Length, B. P.	530′-0″
Breadth, molded	66′-0″
Depth, molded, shelter deck	45′-0″
Draft, loaded	28′-0″
Draft, light	
Block coefficient	0.82
Midship section coefficient	
Longitudinal coefficient	
Speed, loaded, knots	14.5
Cruising radius, nautical miles	
Framing	Transverse
Class	100A-1 Lloyds

Tonnages

(In tons of 2,240 pounds)

*Weight of Hull	
**Weight Propelling Machinery	
Deadweight Capacity	
Displacement	24,000

(In tons of 100 cubic feet)

Gross register	14,500
Net register	

*Weight of Hull includes Hull Proper, Hull Fittings, Equipment, and Outfit.

**Weight of Propelling Machinery includes Engines, Boilers (Wet), Shafting, Propellers, and Machinery Space Auxiliaries.

Canal Ratings

(In tons of 100 cubic feet)

	Gross	Net
Suez		
Panama		

Equipment

2 Bower anchors, stockless, each	113 cwts.
1 Bower anchor, stockless	97 cwts.
1 Stream anchor, ex-stock	34 cwts.
1 Kedge anchor, ex-stock	18 cwts.
Chain cable, 2-15/16″ stud link	330 fms.
Stream line, 1-11/16″ stud link	150 fms.
Towline, 7″ steel wire	130 fms.
Hawsers and warps	
4 lengths 3″ steel wire, each	120 fms.
4 lengths 8″ manila, each	120 fms.

Rudder

Area

Dia. Stock

C. Press. abaft C. L. pintles

Complement

Deck officers	7
Deck crew	58
Engineer officers	7
Engineer crew	66
Purser's and steward's department	125
Total officers and crew	263
First-class passengers	143
Second-class passengers	131
Third-class passengers	366
Total passengers	640
Total complement	903

Handling Equipment

	No.	Type	Capacity	Length
Masts	2	Pole		
Derrick posts	8	Steel		
Booms	18	Steel	5 Ton	
Booms	6	Steel	10 Ton	
Booms	8	Steel	3 Ton	

Deck Machinery

(Number, Size, Type)

Stering Gear .....Steam gear of Brown Bros., Edinburgh.

Windlass	Steam
Capstans	2
Winches, cargo, 11	8″x12″
Winches, boat, 4	8″x12″

Life Saving Equipment

	No.	No. of Persons	Length
Lifeboats	8	52	27′-3″
Lifeboats	2	51	27′-3″
Lifeboats	5	62	28′-0″
Lifeboats	2	20	20′-0″
Boats, motor	2	30	30′-0″

Propelling Machinery

Boilers

Number	4
Type	Double-ended Scotch
Length	
Width or Diameter	
Furnaces, each boiler	8
Fuel	Coal
Draft	Natural
Total heating surface, square feet	
Total grate surface or furnace volume	
Superheat, degrees F	
Working pressure, lbs. per sq. in.	190
Normal fuel consumption:	
Per day, tons	
Per horsepower hour, pounds	
Normal steam production:	
Per hour per pound of fuel	lbs.
Total per hour	lbs.

Engines

Number	2 sets steam turbines
Type	Parsons's double reduction geared
Size	
Horsepower	

Propellers

Number	2
Type	3 bladed—built up
Weight	
Diameter	
Pitch	
R. P. M.	95
Projected area	
Developed area	

Auxiliary Machinery

(Number, Size, Type)

Machinery Space

Condensers

Evaporators

Distiller

Filters

Feed water heater

Fuel oil heaters

Pumps

Refrigerating Machinery

Electric Equipment

Generators....Three 60 k.w.-100 volt steam driven.

Radio .....Marconi installation

Emergency..One 33 k. w.-100 volt paraffin driven.

Holds

No.	Length	Hatches
1	63′-0″	15′-9″ x 16′-0″
2	61′-0″	25′-0″ x 16′-0″
3	70′-0″	12′-6″ x 16′-0″
4	65′-0″	17′-6″ x 16′-0″
5	52′-6″	17′-6″ x 16′-0″
6	50′-0″	15′-0″ x 16′-0″

Capacities

Cargo Space

Compartment

Hold No. 1

" " 2

" " 3

" " 4

" " 5

" " 6

Lower 'tween decks

Frs. 177-205

" 152-177

Main 'tween decks

Frs. 193-205 special cargo

" 177-193

" 168-177 special cargo

" 152-168

" 124-152

" 47 - 52 special cargo

" 38 - 47

" 31 - 38 specie room

" 11 - 20 special cargo

Refrigerated Space

Compartment	Cu. Ft.
Refrigerated chambers & dry stores	14,000

Bunkers

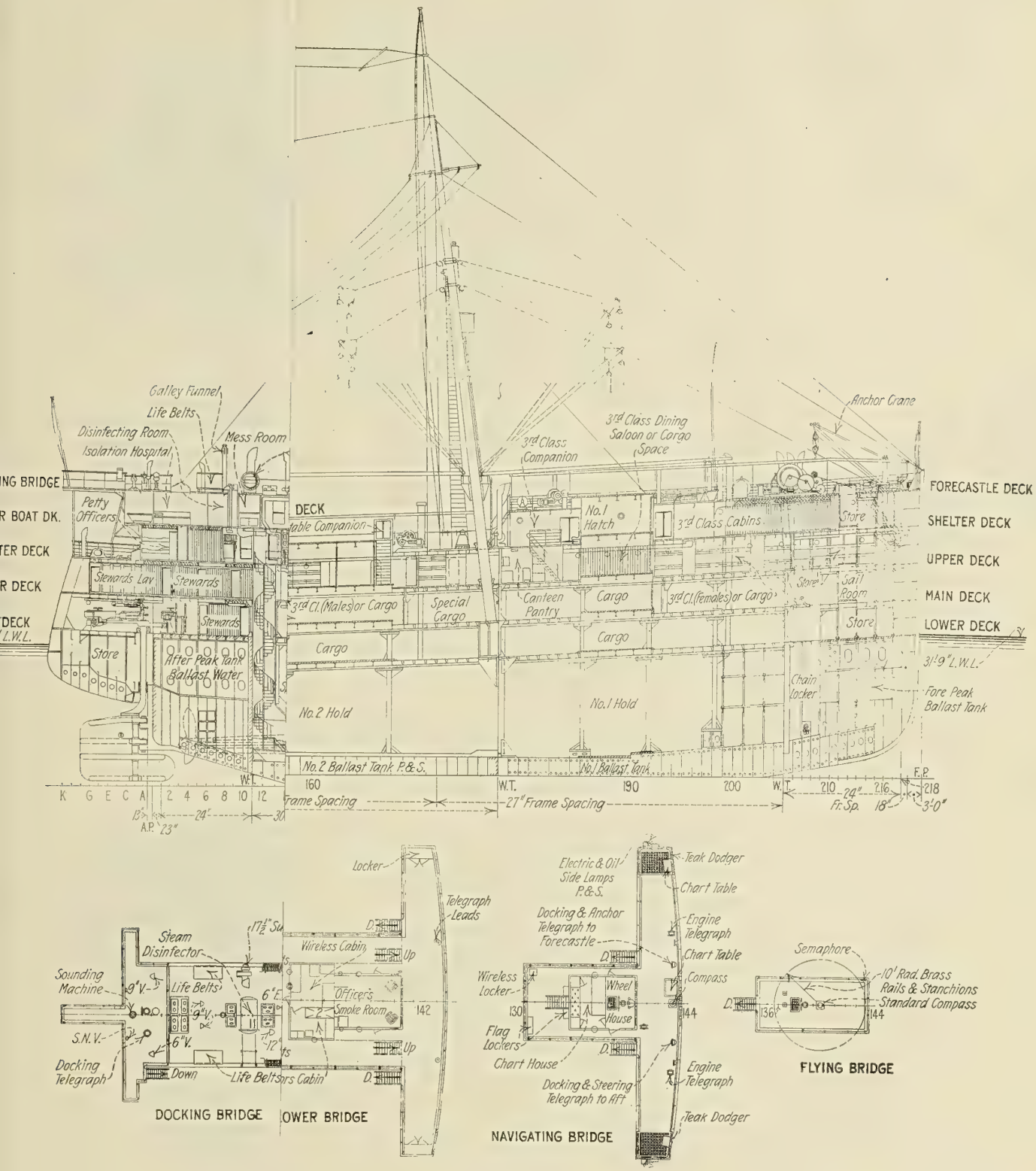
Compartment	Cu. Ft.	*Bbls.	*Tons
Port Hold Bunkers			
Star. Hold Bunkers			
Port 'Tween Deck Bunkers			
Star. 'Tween Deck Bunkers			

*....cu. ft. per ton;.....gals, per bbl.

Tanks

Compartment	Cu. Ft.	Tons F. W.	Tons S. W.
Fore Peak Ballast			
No. 1 Ballast			
No. 2 Ballast, P. & S.			
No. 3 Ballast, P. & S.			
No. 4 Fresh Water, P. & S.			
No. 5 Fresh Water, P. & S.			
No. 6 Ballast, P. & S.			
No. 7 Reserve Feed, P. & S.			
No. 8 Ballast, P. & S.			
No. 9 Ballast			
After Peak Ballast			
F. W., Frs. 46-52 between tunnels			
F. W., Frs. 31-52 at side of tunnels			
Total			

A


Galley Funnel
Life Belts
Disinfecting Room
Isolation Hospital
Mess Room
3rd Class Dining Saloon or Cargo Space
3rd Class Companion
Anchor Crane
ING BRIDGE
R BOAT DK.
TER DECK
R DECK
DECK
L.W.L.
Petty Officers
DECK
able Companion
No.1 Hatch
3rd Class Cabins
Store
FORECASTLE DECK
SHELTER DECK
UPPER DECK
MAIN DECK
LOWER DECK
Stewards Lav
Stewards
Stewards
Store
Sail Room
3rd Cl.(Males) or Cargo
Special Cargo
Canteen Pantry
Cargo
3rd Cl.(Females) or Cargo
Cargo
Cargo
Store
After Peak Tank Ballast Water
3'-9" L.W.L.
Chain Locker
Fore Peak Ballast Tank
No.2 Hold
No.1 Hold
No.2 Ballast Tank P.&S.
No.1 Ballast Tank
W.T.
F.P.
K G E C A 2 4 6 8 10 12
160
W.T.
190
200
W.T.
210
24"
216
218
Frame Spacing
27" Frame Spacing
Fr. Sp.
18"
3'-0"
13"
24"
30
A.P.
23"
Locker
Telegraph Leads
Steam Disinfector
Wireless Cabin
Up
Sounding Machine
9" V.
Life Belts
6" E.
Officers Smoke Room
142
9" V.
S.N.V.
6" V.
Docking Telegraph
Down
Life Belts
Up
DOCKING BRIDGE
LOWER BRIDGE
Electric & Oil Side Lamps P.&S.
Teak Dodger
Chart Table
Docking & Anchor Telegraph to Forecastle
Engine Telegraph
Chart Table
Compass
Wireless Locker
Wheel House
130
144
Flag Lockers
Chart House
Docking & Steering Telegraph to Aft
Engine Telegraph
Teak Dodger
NAVIGATING BRIDGE
Semaphore
10" Rad. Brass Rails & Stanchions
Standard Compass
136
144
FLYING BRIDGE
Trimming Hatch
9" E.V.
9" S.V.
W.T.

PASSENGER AND CARGO STEAMER OROPESA

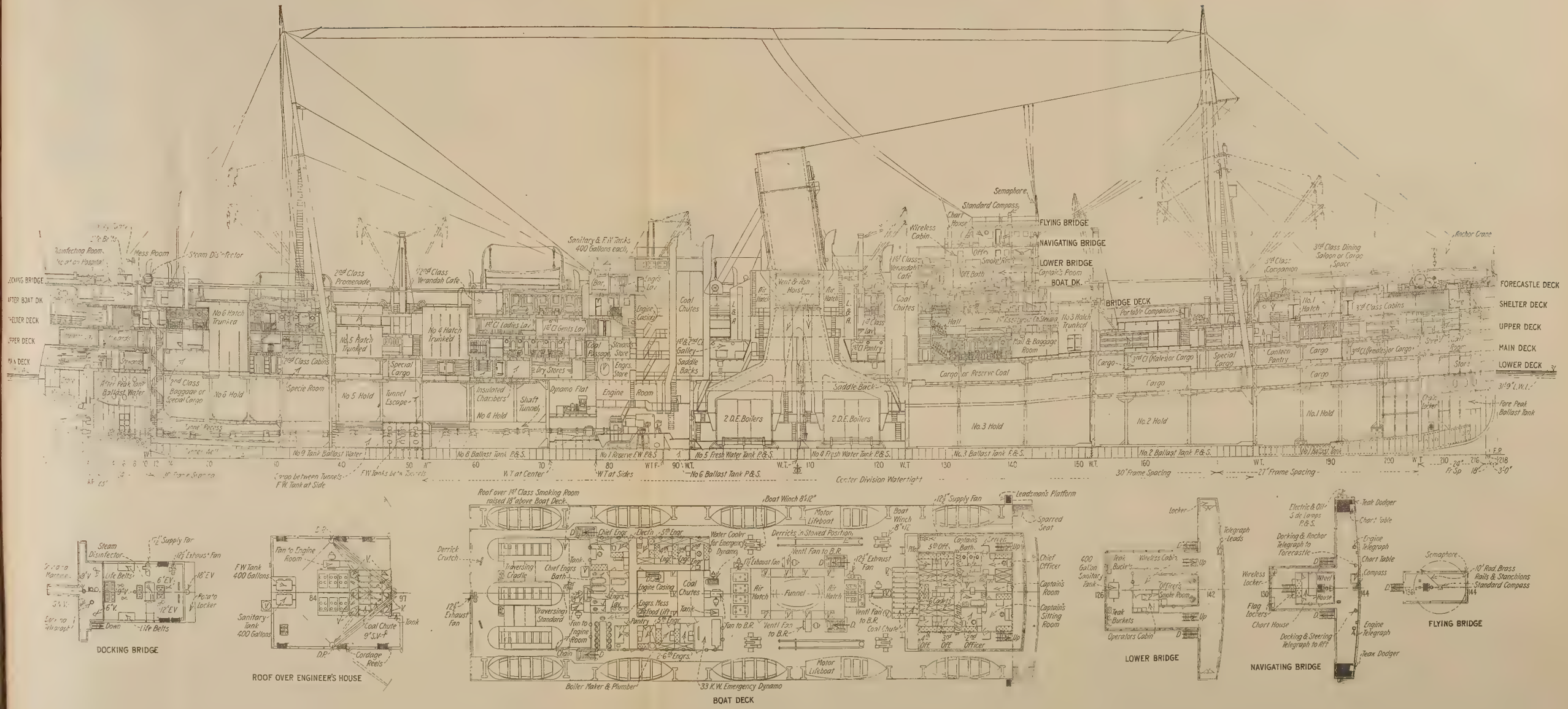
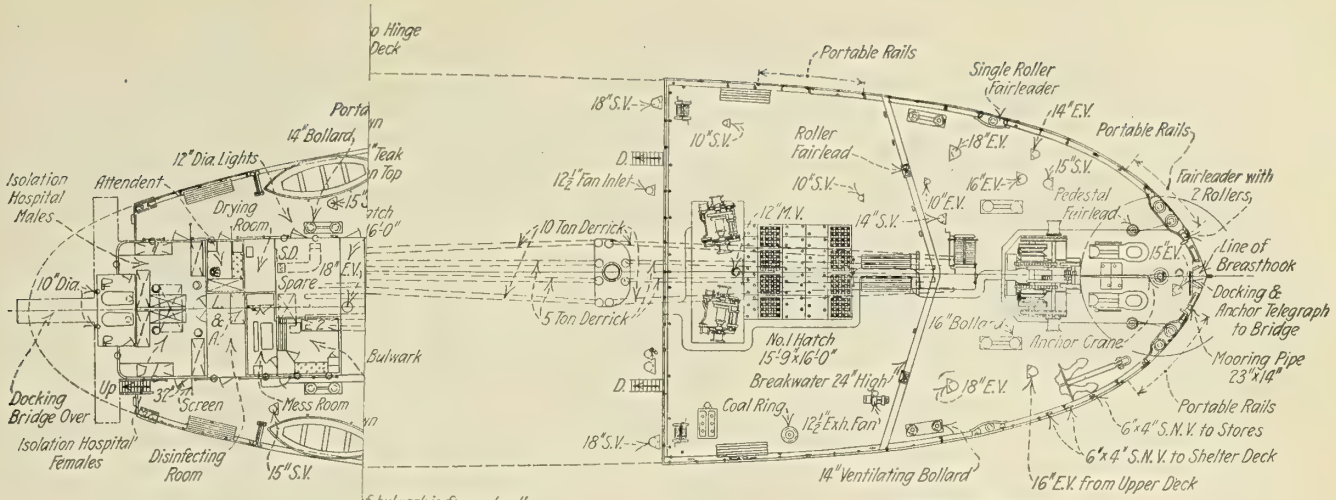


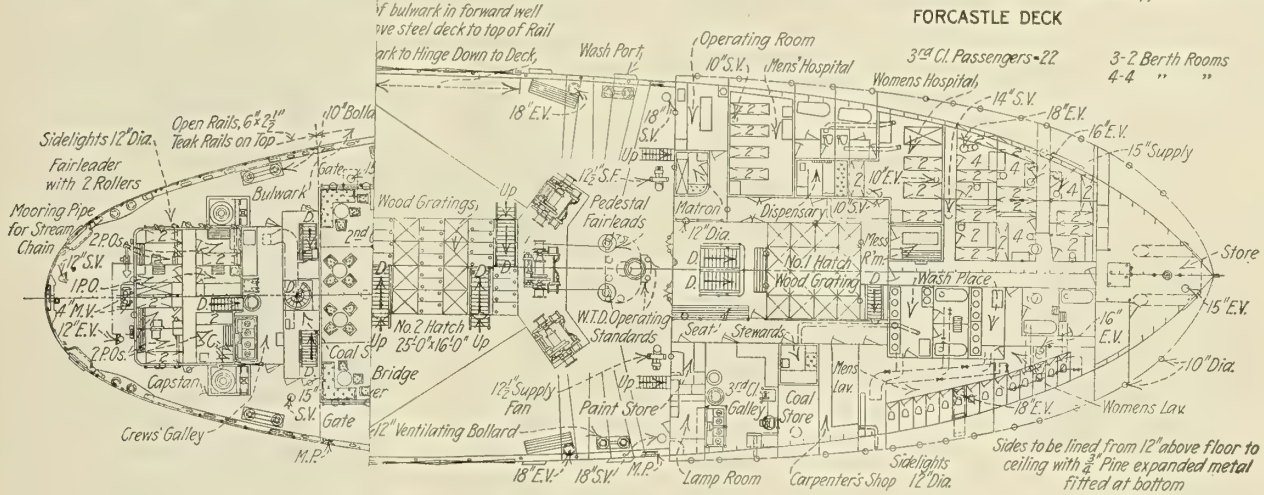
Fig. 8.—Profile and Upper Decks

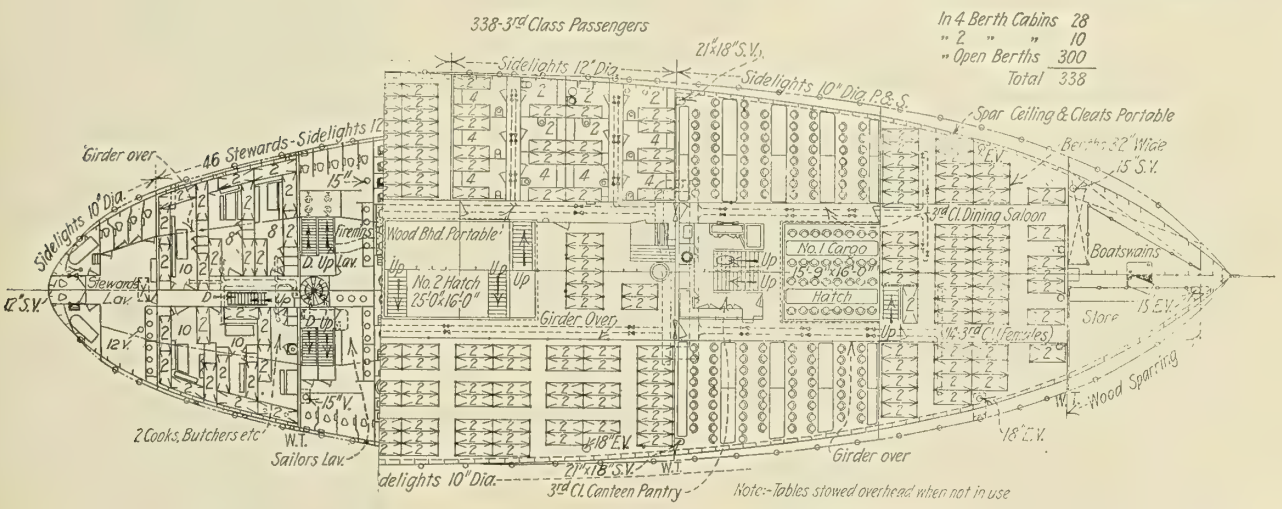
1921
OFFICE

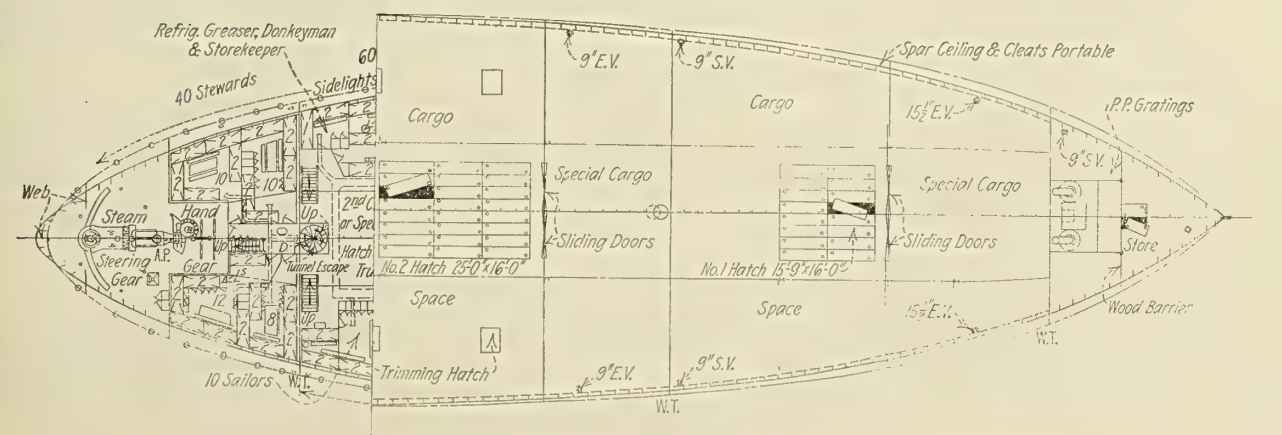
ESA



FORCASTLE DECK







PASSENGER AND CARGO STEAMER OROPESA

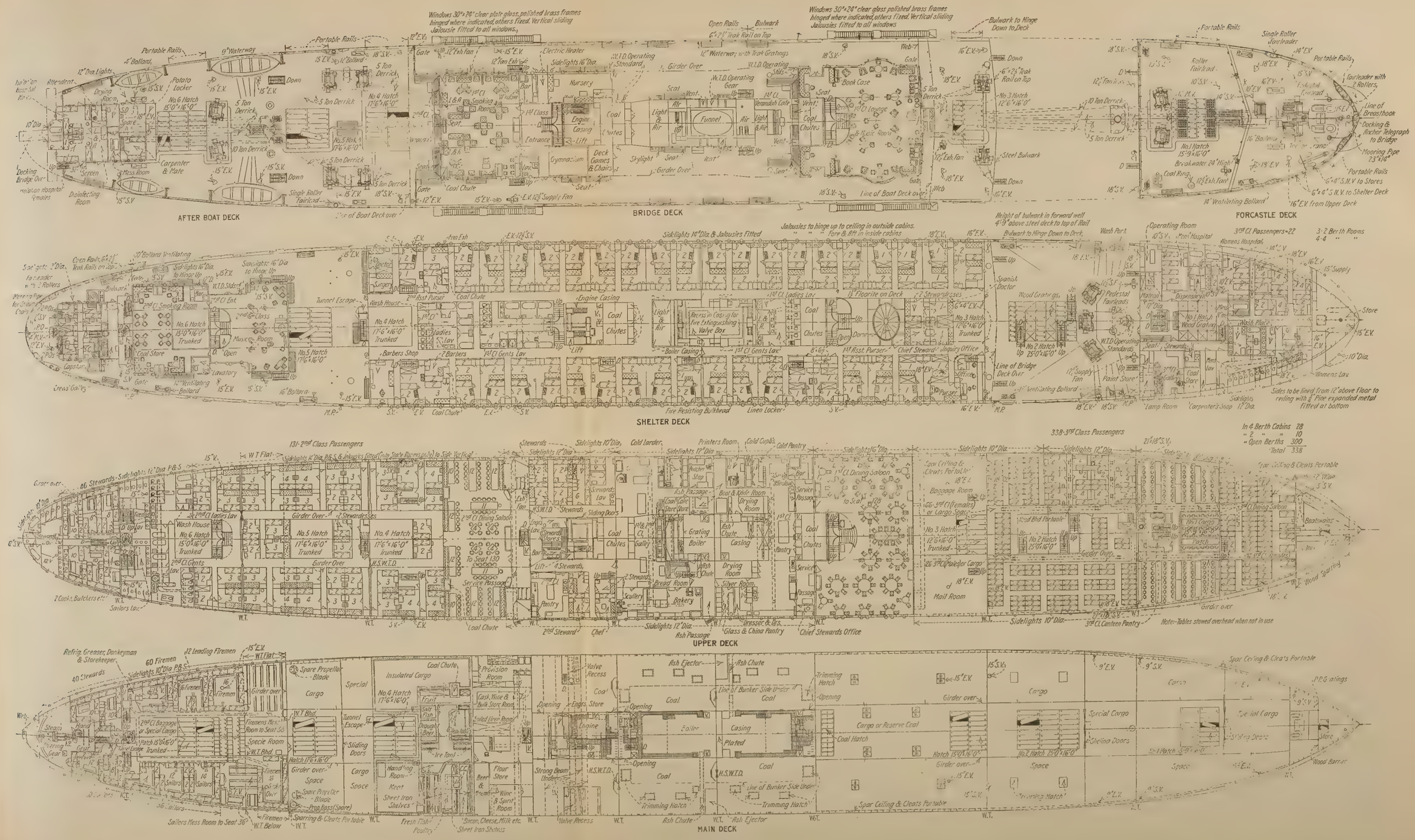


Fig. 9.—Deck Plans

At the aft end of the lounge is the first class veranda, fitted out in the usual manner with teak seats, tables, etc.

The first class smoking room, located amidships on the bridge deck, is a spacious room with raised ceiling. The ceiling is covered with fibrous plaster and the walls are framed in oak and panelled. The furniture is arranged in an attractive manner and comprises circular and square top tables, elbow chairs, settees, etc. The floor is laid with Rublino tiles to tone with the general effect.

Adjoining the smoking room is a nursery on the port side and a gymnasium on the starboard, each well fitted out with the usual appliances.

First class passengers are berthed on the shelter deck amidships. The staterooms are framed in panelled pine and are enameled white. Single berth cabins with cot beds are a feature of this accommodation.

Forward on the upper deck is the first class dining saloon with seating accommodation for 128. Over the dining saloon is a large ornamental dome. The furniture is well arranged, and the walls are framed in light oak to special design. The panelled ceiling is of fibrous plaster finished in white enamel relieved with gold and the floor is laid with Rublino tiles.

The midship portion of the upper deck is taken up by the saloon galleys and pantries equipped with all the latest appliances.

Second Class

On the bridge deck aft of the first class smoking room is situated the second class veranda with seats and tables.

At the aft end of the shelter deck is the second class smoking room and second class music room. The walls of the former are framed in oak, while the ceiling is covered with venesta neatly ornamented and the floor with Rublino tiles. The second class music room adjoining is decorated in mahogany with distinctive carvings and moldings. The ceiling of this room is also covered with ornamented venesta, and finished in white with gold relief, the floor being also laid with Rublino tiles.

Aft of the galleys and pantries on the upper deck is situated the second class dining saloon with a seating accommodation of 130. The furniture in this saloon is in polished mahogany. The walls are panelled in hardwood and finished in white enamel.

Second class passengers are berthed in staterooms at the after end of the upper deck. The staterooms are framed in panelled pine and enamelled white.

Third Class

Third class passengers are berthed in staterooms under the forecastle and upper decks and in open berths at the forward end of the upper deck.

The third class dining saloon, situated forward on the upper deck, has a seating accommodation of 160, and is furnished in a plain but substantial manner.

Under the forecastle is a well fitted galley for the service of the third class passengers and separate hospitals for men and women, with operating room attached. On the starboard side forward are situated the third class lavatories and bathrooms.

Crew Accommodations

Officers' accommodations are located on the boat deck, the captain and deck officers at the forward end and the engineers at the after end; complete with cabins, bathrooms, lavatories, etc.

The sailors and firemen are berthed aft.

Cargo Handling Gear

Cargo is handled by means of steel tubular derricks fitted to the masts and four special steel derrick posts, two forward and two aft, viz. two 10-ton and two 5-ton on the main mast, four 10-ton and four 5-ton on the fore mast, four 5-ton on each of the after posts, two 5-ton on each of the forward posts. The cargo is worked by eleven 8-inch by 12-inch winches substantially fastened to the deck by girders. A large specially designed crane is also fitted on the forecastle head for working the stockless anchors when required.

The coaling for the ship is done by means of large coaling hatches on the boat deck which extend to the bunkers and 'tween deck holds. Four steel derrick posts are fitted with two 3-ton steel tubular derricks attached to each for working the coal, power being supplied by the four 8-inch by 12-inch boat winches.

Life Saving Equipment

Lifeboats worked by Welin's patent davits are supplied with ample capacity to accommodate all persons on board should necessity arise. On the after end of the boat deck a number of these boats are stowed across the ship on a traversing cradle to enable their being shifted to either side of the vessel.

Main Propelling Machinery

Propulsion is by two sets of Parson's double reduction geared turbines of the latest improved type, driving twin screws. Each set of turbines consists of one high pressure, one intermediate and one low pressure turbine coupled to the main shaft by means of double reduction gearing, compound astern turbines of the impulse reaction type being incorporated in the intermediate and low pressure casings.

The propeller revolutions at full power will be about 95 per minute, while the turbine revolutions will be 3,500 per minute for the high pressure and intermediate turbines and 1,800 per minute for the low pressure turbines.

The main condensers are suspended from the low pressure turbines and are designed for a high vacuum.

Michell type main thrust blocks are provided.

The twin propellers have bosses of cast iron with separate blades of manganese bronze.

There are four double ended boilers of the cylindrical marine type working at a pressure of 190 pounds per square inch. Each boiler has eight furnaces and the boilers are designed for natural draft.

The installation is supplied with high class auxiliary machinery and the whole of the machinery has been built to the requirements of the Board of Trade and Lloyd's Registry of Shipping under the supervision of Mr. Lee Wood, the company's superintendent engineer.

Aft on the main deck is the steering compartment with a large hand and steam steering gear supplied by Brown Brothers of Edinburgh.

Marconi wireless is also fitted.

The vessel is fitted with a large steam windlass and at the after end of the shelter deck are two powerful warping capstans and two special fairleads for working the ship when going through the Panama Canal.

The whole ship is ventilated by natural methods assisted by high powered fans.

Electric light is provided throughout the vessel, the installation consisting of three 60 kilowatt 100 volt steam-driven dynamos. On the boat deck is a 33 kilowatt 100 volt paraffin-driven emergency dynamo, all to International Convention requirements.

New Service Begins This Month.—As one of the several developments among the various lines operating on the Atlantic, the Royal Mail Steam Packet Company will have its first eastbound sailing from New York early this month, when the *Orbita* sails for Liverpool. She will be followed by the *Oropesa* and *Orduna*. These steamers have been plying on the South American service of the Royal Mail and will be refitted for the more temperate zones.

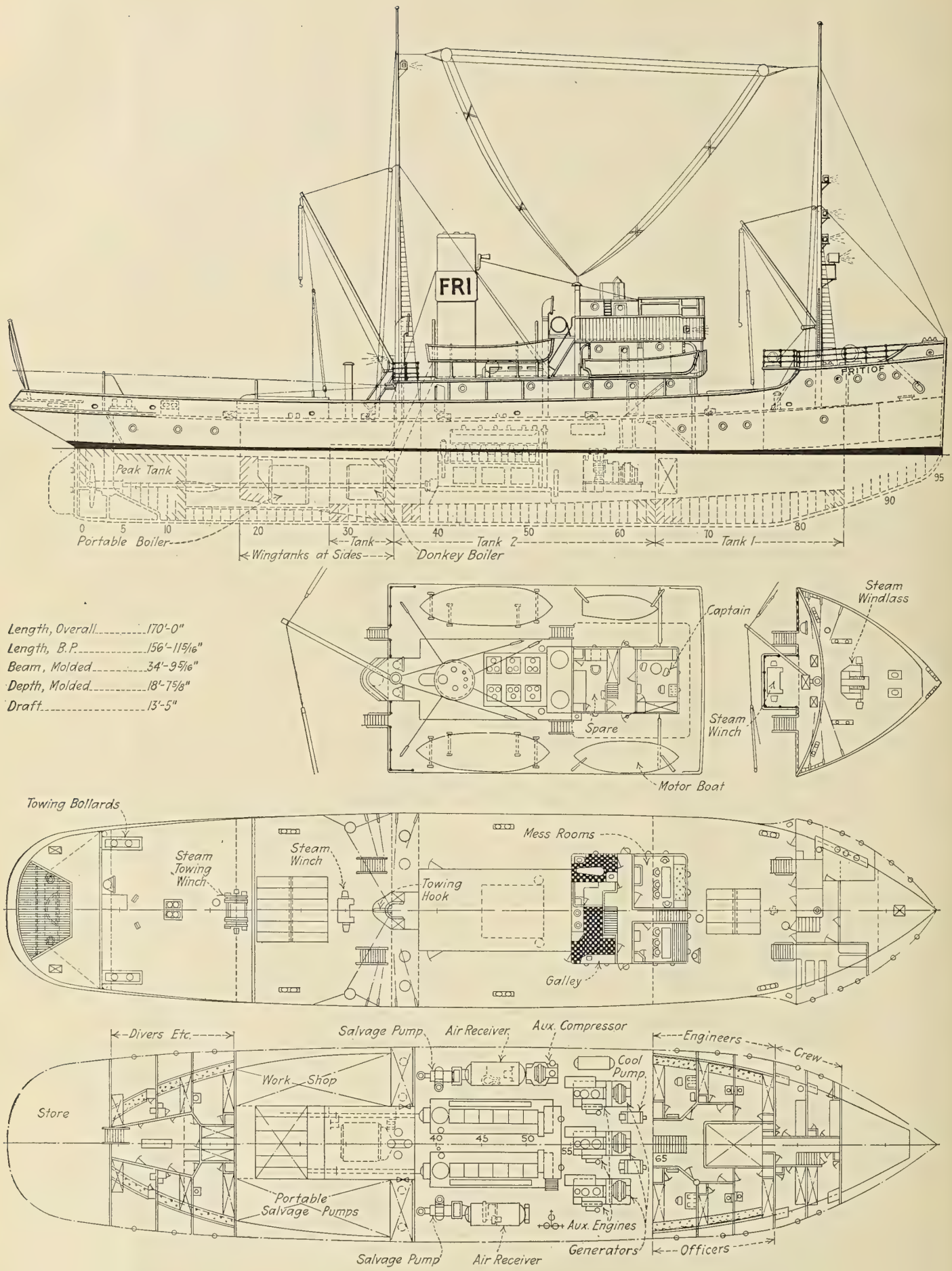


Fig. 1.—Profile and Deck Plans of Salvage Ship *Fritiof*

Salvage Motor Vessel Fritiof

New Type of Motorship Built in Sweden for the Gothenburg Towing and Salvage Company

A POWERFUL Diesel motor driven salvage ship has lately been built by the Götaverken, of Gothenburg, the biggest shipyard in Sweden, and handed over to its owners the Gothenburg Towing and Salvage Company.

In deciding upon Diesel propelling engines and Diesel-electric and electric-pneumatic auxiliary and salvage machinery, the owners took a bold step, as the *Fritiof* is equal to and probably superior in size and power to all existing steam driven salvage ships.

One valuable advantage of Diesel power for a salvage vessel is that in all cases of emergency she is ready for instant start, with a minimum of stand by charges, instead of having to keep steam up with its continuous consumption of coal or oil fuel. In addition the cruising radius of the ship is three to five times as large, thus allowing her to remain operating at the scene of a wreck for a much longer period without re-fueling.

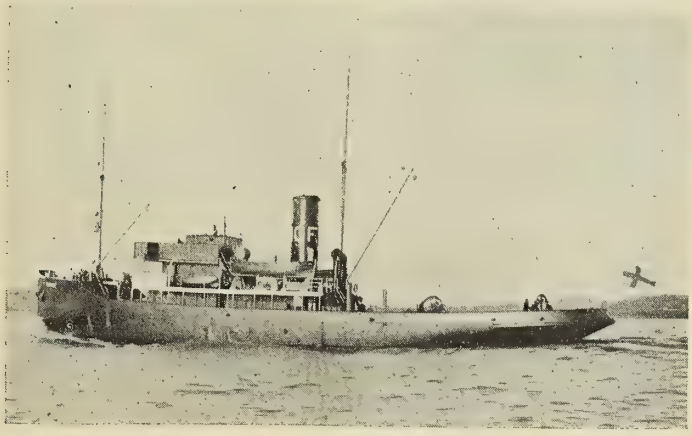


Fig. 2.—Swedish Salvage Ship *Fritiof*

Principal Dimensions

The principal dimensions of the *Fritiof* are as follows:

Length, overall	170 feet
Length, between perpendiculars	156 feet 11 5/16 inches
Breadth, molded	34 feet 9 5/16 inches
Depth, molded	18 feet 7⅝ inches
Draft, with 250 tons fuel and cargo	13 feet 5 inches
Horsepower, indicated	1,250

Main Propelling Machinery

The *Fritiof* is a twin screw ship propelled by two four cycle Burmeister and Wain type Götaverken-built Diesel engines, each with an output of 625 indicated horsepower from six cylinders 15.748-inch bore by 29.527-inch stroke at 150 revolutions per minute.

Auxiliary Machinery

In addition there are three 90 indicated horsepower Diesel engines coupled to electric generators which furnish current to the following electric motor-driven equipment:

2—16 inch salvage pumps in the engine room
3—8 inch portable salvage pumps
2 portable plunger pumps

The windlass, steering gear, two 5-ton winches and one 10-inch towing winch are steam driven and the rigging is designed for 10 tons lift.

There are also three 8-inch motor driven portable salvage pumps and one 12-inch steam driven salvage pump, the total capacity of all the pumps being 6,000 tons per hour.

General Arrangement

The general arrangement of the machinery and accommodations are illustrated by Fig. 1, the captain, spare room, mess room, galley and bath being located in a deck house amidships, the officers and crew under the deck forward and the divers and spare accommodation under the deck aft. There are good clear deck spaces for working the salving outfit and a hold aft for a portable boiler and workshop, also a roomy hold forward.

Not only the builders, Götaverken, but also the owners are confident that this new ship will prove a success. The first trip of the vessel, towing a 7,000-ton floating dock across the Baltic sea with a speed of 6 to 7 knots, showed that she was able to develop more power than anticipated.

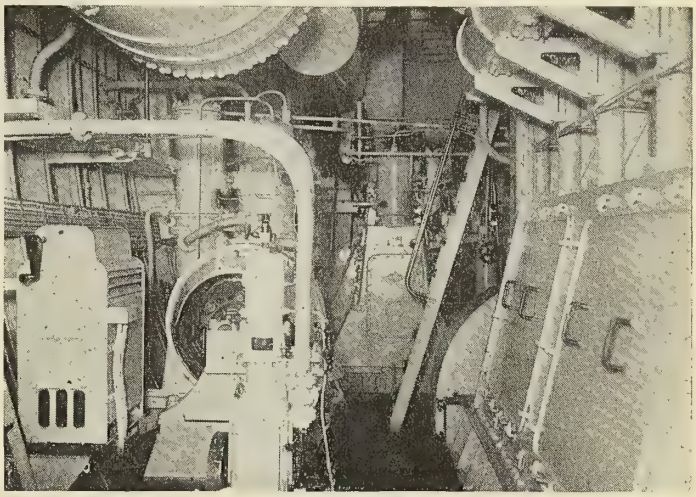


Fig. 3.—Port Side of Engine Room, Looking Forward

The Gothenburg Towing and Salvage Company has a fleet of 25 tugs and steamers up to 700 indicated horsepower in addition to lighters and pontoons for salvage work. With the new Diesel boat in commission the company will be fully able to meet all demands in the way of salvage work on the coasts of Scandinavia as well as further away.

The steamship *Mirzapore*, which was launched recently from the Walker yard of Sir W. G. Armstrong Whitworth & Company, Ltd., is one of the standard cargo vessels purchased from the Shipping Controller by the Peninsular and Oriental Steam Navigation Company, Ltd.

The principal dimensions of the vessel are:

Length between perpendiculars	411 feet 6 inches
Breadth, molded	55 feet 6 inches
Depth, molded	38 feet 1½ inches
Gross tonnage	6,700 tons

The vessel is of the single deck type with shelter deck, poop and forecastle having a cruiser stern and constructed on the Isherwood system. The propelling machinery consists of a set of geared turbines manufactured by the Parsons Marine Steam Turbine Company, Ltd.

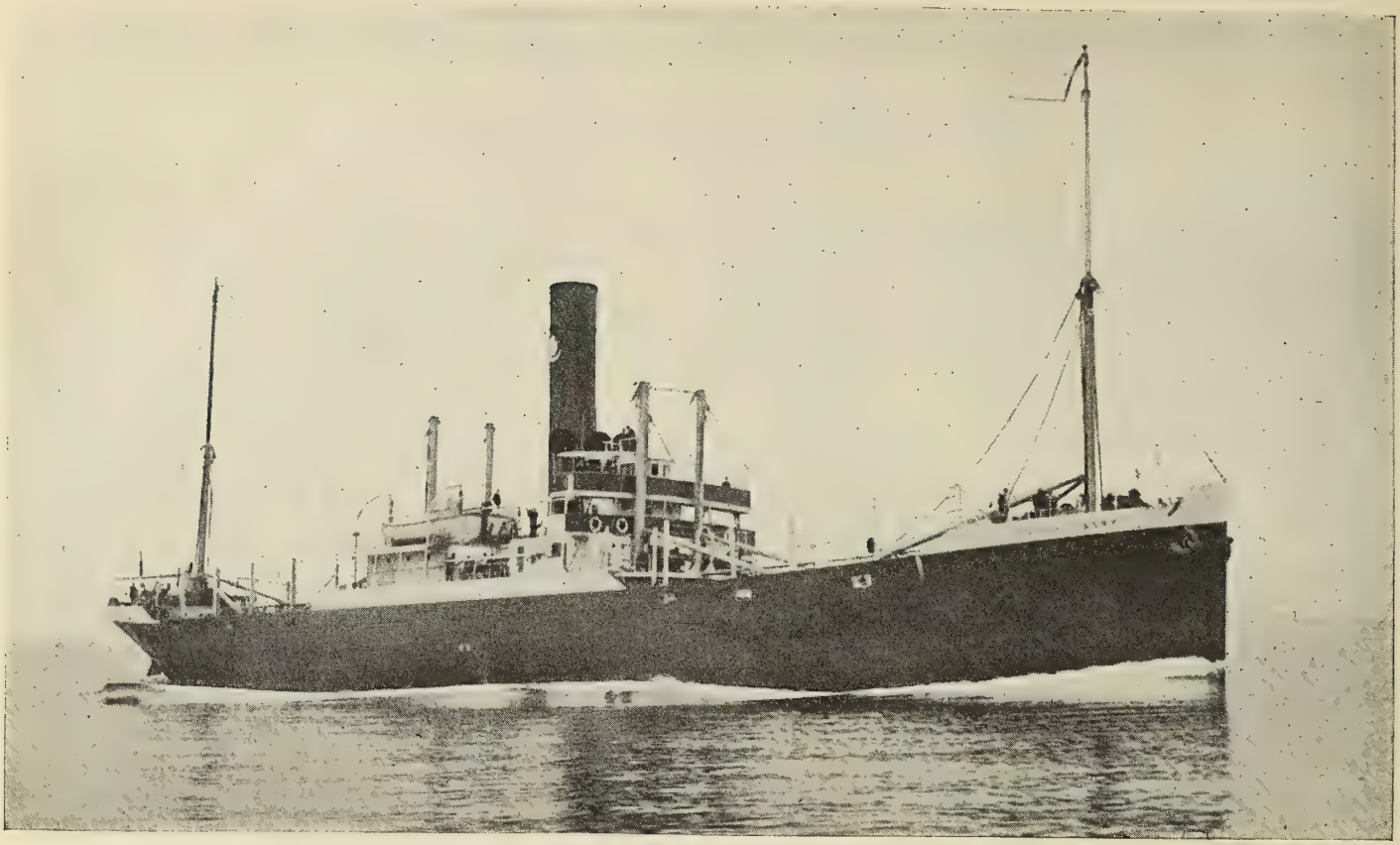


Fig. 1.—S. S. *Nelly Lasry*

Wine Steamers Nelly Lasry and Sidney Lasry

4,000 Deadweight Ton Vessels Specially Designed to Meet the Requirements of the French Wine Trade

THERE follows a description of the steamships *Nelly Lasry* and *Sydney Lasry,* specially designed and built for service in the French wine trade by The Burntisland Shipbuilding Company, Ltd., Burntisland, Fife, Scotland, to the account of Monsieur Joseph Lasry, of Oran and Paris.

The vessels are of the two deck type, with machinery space amidships, and have been built under Lloyd's special survey and classed 100 A-1*, also in accordance with French law.

While special attention has been given to the structural arrangements with a view to the fabrication of parts and speedy construction, the height for holds and 'tween decks, built pillars, depth of beams and knees, etc., have been arranged for the easy stowage of wine barrels in tiers.

It will be observed from Fig. 2 that the number and location of the winches and derricks, together with large, clear hatchways, are such as to provide for quick loading and discharging of cargo. In order to leave the wells clear of all obstructions the winches, masts and derrick posts are arranged on the poop, bridge and forecastle decks with fore and aft gangways fitted between these erections. This, together with a system of deck cargo supports and wires, provides a clear space for the stowage of wine barrels or other deck cargoes.

There are two cargo holds and one 'tween decks forward of the machinery space and one large cargo hold, divided into two by a wooden bulkhead, and one 'tween decks aft.

Four steel watertight bulkheads to the upper deck are provided and one steel watertight bulkhead to second deck dividing Nos. 1 and 2 holds.

Water ballast is carried in the double bottom and peak tanks, with the exception of the engine room tank, which is arranged for fresh water only, and the boiler room tank, which is a dry tank.

Tonnage openings are arranged in the after end bulkhead of the bridge, while the forecastle is permanently open, the bridge and forecastle 'tween decks being thus exempt from tonnage measurement.

There are four large cargo hatchways through the upper deck, each 27 feet long by 18 feet wide, with coamings 3 feet high and four hatchways of similar dimensions, but with angle coamings arranged in second deck. In addition, a trunked hatch 4 feet 6 inches long by 12 feet wide passes through the bridge deck and saloon house, and immediately below, in the upper and second decks, are additional hatches 6 feet 9 inches long by 18 feet wide.

Permanent coal bunkers are built at the port and starboard sides of the machinery space, and a coal chute is arranged through the boiler casing opening into the bridge 'tween decks, in which additional coal may be carried when necessary. The side bunkers are fed through bunker hatches 15 feet 6 inches long by 3 feet wide in the upper deck, with smaller hatches 4 feet 3 inches long by 3 feet wide arranged immediately above on the bridge deck.

Accommodations

The saloon and owner's cabin are arranged in a large steel deck house at the fore end of the bridge deck. On top of the saloon house is another house containing the captain's day and night cabin, while above on the flying bridge there is a steel house containing the chart room and wheel house.

M

E.

Fro

One
Shelf

WINE STEAMERS NELLY LASRY AND SIDNEY LASRY

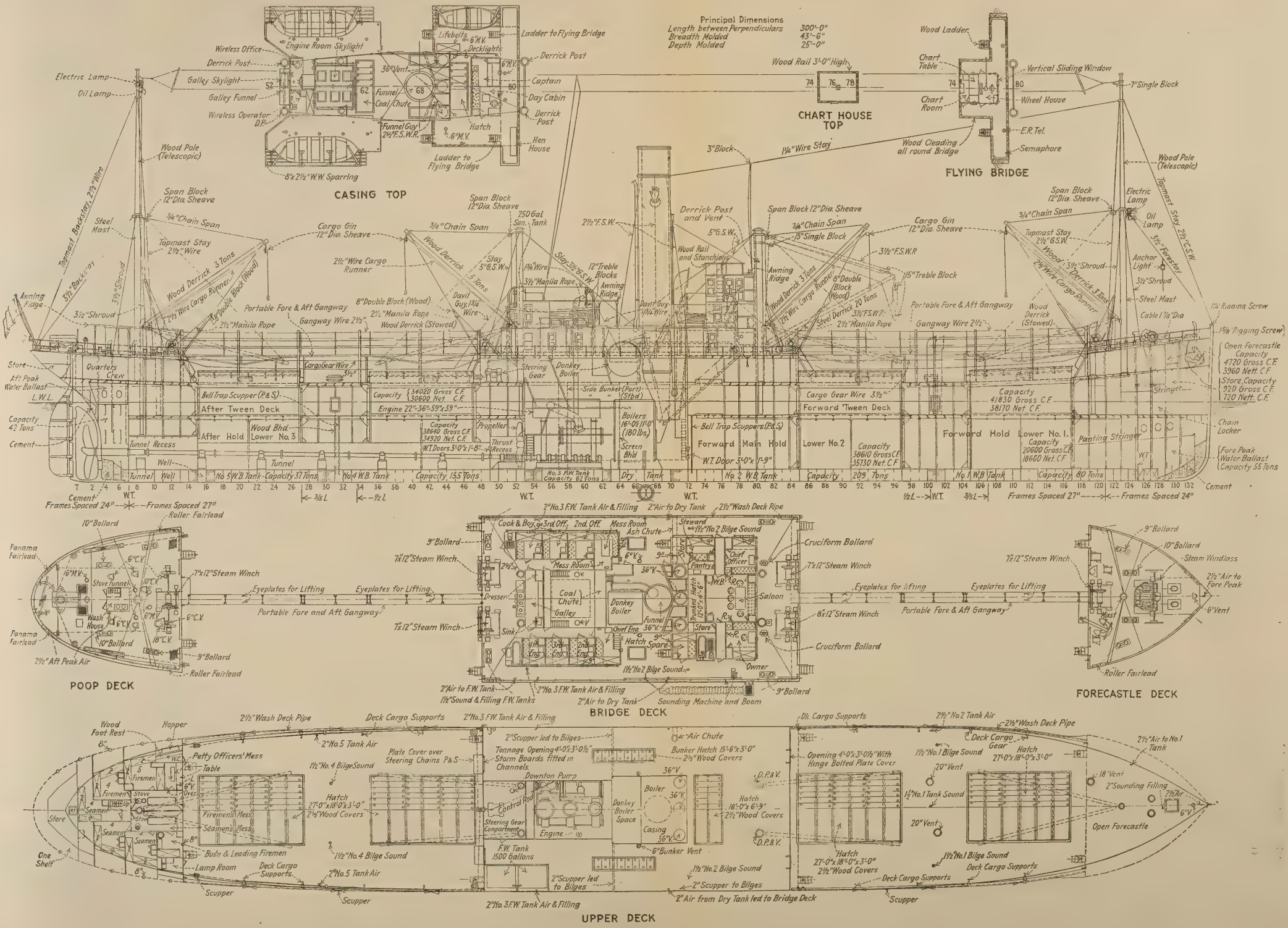


Fig. 2.—Profile and Deck Plans

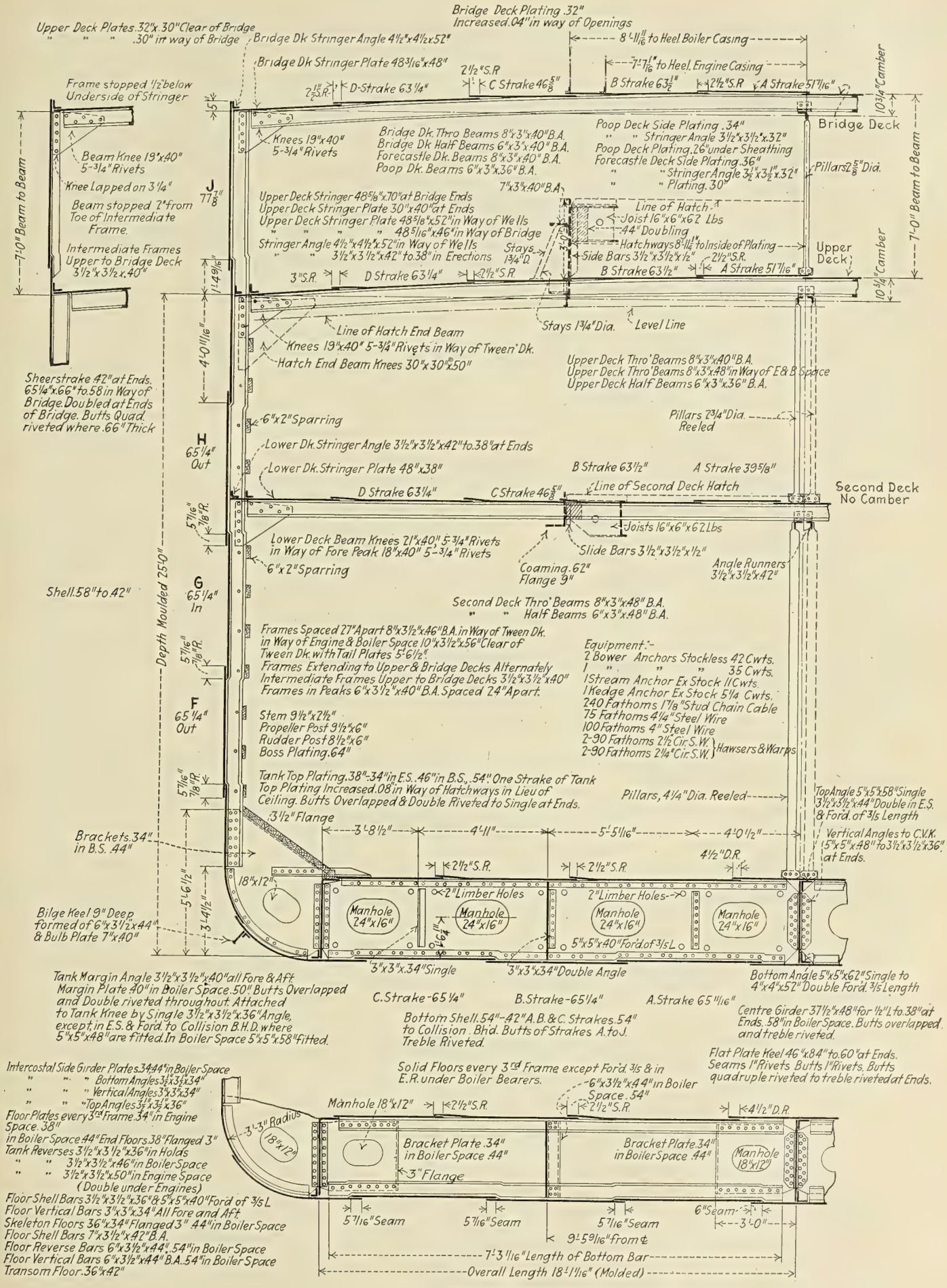


Fig. 3.—Midship Section

Wine Steamers Nelly Lasry and Sidney Lasry

General Information

Service: French wine trade.

Builder: Burntisland Shipbuilding Company, Ltd., Fife, Scotland.

Owner: Mons. Joseph Lasry of Oran and Paris.

Characteristics

Length, overall ..... 312'-6"
Length, B. P. ..... 300'-0"
Breadth, molded ..... 43'-6"
Depth, molded, upper deck ..... 25'-0"
Draft, loaded ..... 21'-0"
Draft, light .....
Block coefficient .....
Midship section coefficient .....
Longitudinal coefficient .....
Speed, loaded, knots .....
Cruising radius, nautical miles .....
Framing ..... Transverse
Class 100 A-1 Lloyd's special survey and in accordance with French law.

Tonnages

(In tons of 2,240 pounds)

*Weight of Hull .....
**Weight Propelling Machinery .....
Deadweight Capacity 4,000
Displacement .....

(In tons of 100 cubic feet)

Gross register .....
Net register .....

* Weight of Hull includes Hull Proper, Hull Fittings, Equipment, and Outfit.

** Weight of Propelling Machinery includes Engines, Boilers (Wet), Shafting, Propellers, and Machinery Space Auxiliaries.

Canal Ratings

(In tons of 100 cubic feet)

	Gross	Net
Suez		
Panama		

Equipment

2 Bower anchors, stockless, each..42 cwts.
1 Bower anchor, stockless .....35½ cwts.
1 Stream anchor, ex-stock .....11 cwts.
1 Kedge anchor, ex-stock .....5¼ cwts.
240 Fms. 1⅞" stud chain cable.
75 Fms. 4¼" steel wire.
100 Fms. 4" steel wire.
2-90 Fms. 2½" steel wire.
2-90 Fms. 2¼" steel wire.

Rudder

Area .....
Dia. Stock .....
C. Press. abaft C. L. pintles .....

Complement

Deck officers	4
Deck crew	14
Engineer officers	4
Engineer crew	10
Purser's and steward's department	3
Total officers and crew	37
First-class passengers	2
Second-class passengers	none
Third-class passengers	none
Total passengers	2
Total complement	39

Handling Equipment

	No.	Type	Capacity	Length
Masts	2	Pole		
		Steel		
Derrick posts	4	Steel		
Booms	8	Wood	3 ton	
Booms	1	Steel	20 ton	

Deck Machinery

(Number, Size, Type)

Steering Gear steam .....
Windlass, 1 steam .....
Capstans .....
Winches 5 ..... 7"x12" steam
1 ..... 8"x12" steam

Life Saving Equipment

	No.	Type	Length
Lifeboats	2		25'-0"
Dinghy	1		16'-0"

Propelling Machinery

Boilers

Number 2
Type ..... Scotch single-ended
Length ..... 11'-0"
Diameter ..... 16'-3"
Furnaces .....
Fuel ..... Coal
Draft ..... Forced
Total heating surface, square feet .....
Total grate surface or furnace volume ....
Superheat, degrees F .....
Working pressure, lbs. per sq. in..... 180
Normal fuel consumption:
Per day, tons .....
Per horsepower hour, pounds .....
Normal steam production:
Per hour per pound of fuel..... lbs.
Total per hour ..... lbs.

Engines

Number 1
Type reciprocating..... triple expansion
Size ..... 22"x36"x59"x39" stroke
Horsepower .....

Propellers

Number 1
Type .....
Weight .....
Diameter .....
Pitch .....
R. P. M. .....
Projected area .....
Developed area .....

Auxiliary Machinery

(Number, Size, Type)

Machinery Space

Condensers .....
Evaporators .....
Distiller .....
Filters .....
Feed water heater .....
Fuel oil heaters .....
Pumps .....

Refrigerating Machinery

Electric Equipment

Generators .....
Radio ..... 1½ k. w. Marconi
Emergency .....

Holds

No.	Length	Hatches
1		27'-0" x 18'-0"
2		27'-0" x 18'-0"
		6'-9" x 18'-0"
		27'-0" x 18'-0"
3		27'-0" x 18'-0"

Capacities

Cargo Space

Compartment	Cu. Ft. Bulk	Cu. Ft. Bales
Hold No. 1	20,600	18,660
Hold No. 2	38,610	35,730
Hold No. 3	38,640	34,920
Forward 'tween decks	41,830	38,170
After 'tween decks	34,020	30,600
Open foc'sle	4,720	3,960
Store	920	720
Total	179,340	162,760

Refrigerated Space

Compartment	Cu. Ft.

Bunkers

Compartment	Cu. Ft.	*Bbls.	*Tons
Port side bunker			
Star. side bunker			
Port 'tween decks bunker			
Star. 'tween decks bunker			

*....cu. ft. per ton;..... gals. per bbl.

Tanks

Compartment	Cu. Ft.	Tons F. W.	Tons S. W.
Fore peak tank			55
No. 1 tank			80
No. 2 tank			209
No. 3 tank		62	
No. 4 tank			135
No. 5 tank			37
After peak tank			42
Total		62	558

Engineers' and officers' accommodation is arranged in side houses abreast the engine casing, the engineers being berthed on the starboard side and the deck officers on the port side. The galley is arranged between these houses at the after end of the engine casing.

Commodious quarters for the crew are arranged in the poop, members being separated into cabins as far as possible for each watch. Separate mess rooms are provided in the poop for seamen and firemen, and on the deck above is arranged a steel entrance house containing also the washroom for the crew.

Fresh Water Tanks

Two fresh water tanks, each of 1,500 gallons capacity, are arranged at the after end of the bridge 'tween decks on the starboard side, these tanks being filled by means of a Worthington pump situated in the engine room and pumping from the engine room double bottom tank.

Hull

Special features have been introduced in the hull to facilitate construction and simplify the fabrication of parts. It will be noted that the bottom has no rise of floor, the bilge a 3-foot 3-inch radius, and the top sides no tumble home. The parallel middle body is carried well forward and aft without sheer, the sheer being confined to the endmost portions beyond the limits of this parallel body.

A standard rivet pitch of 3⅜ inches has been adopted throughout and the frame spacing, widths of strakes of plating and positions of tank girders have been arranged to suit this pitch. In the case of the side frame, beam, and tank connection bars the rivets are spaced alternately 3⅜ inches and 6¾ inches instead of the usual regular spacing, as the latter arrangements would not have conformed to the standard pitch required.

The heavy bulb angle side frames are all made on straight lines, extending from the upper turn of bilge to the upper or bridge deck alternately, and the variation of the angle at which these straight side frames were set in the case of the ends of the vessel was very carefully worked out with a view to producing a shipshape form.

Widths of shell plating are all equal and measured parallel on the run of the frame, thus permitting a standard template for frame riveting to be used. The frame holes being all worked off the standard template enables a short standard template to be used for marking off the shell plates.

Solid pillars are fitted and reeled to take shifting boards between the hatchways, a single built pillar in lieu of quarter pillars being fitted at hatch ends in conjunction with a deep-built hatch end beam. In way of the hatchways the hatch side coamings form longitudinal deck girders which transmit the loads to the strong transverse hatch end beams.

Steering Gear

The steam steering gear, which is controlled from the flying bridge, is placed in the after end of the engine casing at the upper deck level and controls a quadrant tiller on the rudder head by means of the usual arrangement of chains and rods.

There is also a hand screw steering gear mounted on the rudder head for emergency use.

The rudder is of the single plate type and is supported on a Taylor-Pallister patent rudder carrier. A Taylor-Pallister patent rudder brake is also fitted on the quadrant tiller.

Main Propelling Machinery

The propelling machinery, built by Messrs. Cooper & Greig, Ltd., of Dundee, Scotland, consists of one set of triple expansion engines having cylinders 22 inches, 36 inches and 59 inches in diameter by 39 inches stroke, and two single ended, forced draft, multitubular marine boilers 16 feet 3 inches external diameter by 11 feet mean length, which operate at 180 pounds per square inch working pressure.

For supplying steam for the deck machinery a donkey boiler 9 feet by 9 feet by 100 pounds per square inch working pressure is placed in the casing, at the upper deck level, just abaft the main funnel.

The vessel has an installation of electric lighting, steam heating to accommodation and ample ventilating and mooring arrangements.

A 1½-kilowatt Marconi wireless apparatus is installed, together with telescopic wood topmasts of sufficient height to give a radius of 250 miles by day.

Fire extinguishing pipes and connections are led to each hold, 'tween decks and bunkers in accordance with French law requirements.

These vessels were very successful during their measured mile progressive trials and four hours' continuous runs at sea, when in each case a speed of nearly 13 knots was obtained, this speed being well above that guaranteed by the builders.

The Geared Turbine Propelling Equipment of the New Shawmut Ships

Among the first ships to be contracted for and built by a private firm since the armistice are the *Mount Carroll,* launched on January 10, and her sister ship, the *Mount Clinton,* launched on February 8. Both were built at the Chester, Pa., yards of the Merchant Shipbuilding Corporation for the Shawmut Steamship Company, New York, and will be operated by the United American Lines, Inc., New York, between New York and Hamburg.

The general arrangement plans and a detailed description of these ships as they were originally designed for straight cargo carriers were published in the September, 1920, issue of Marine Engineering, but an interesting change was recently made in their construction owing to the great increase in the immigrant traffic to America. In order to carry this class of passengers westward, and at the same time avoid empty capacity on the eastward voyage, arrangements have been made whereby staterooms with two, four, and six standee berths and accommodating 1,500 people can be quickly erected in the two upper decks, and also be easily removed, leaving clear cargo space, when not needed. Another unique feature is the installation of a kitchen for kosher cooking in order to accommodate Jewish passengers.

These vessels are of the single-screw, shelter-deck type, with the propelling machinery located amidships. They were built and classed to the rules of Lloyd's Register of Shipping, 100A1, and in compliance with the regulations of the United States Steamboat Inspection service. Their principal dimensions are as follows:

Length overall	457 feet
Length between perpendiculars	440 feet
Beam, molded	57 feet
Depth at side to shelter deck	39 feet
Depth at side to upper deck	31 feet
Depth at side to lower deck	22 feet
Draft, designed load	28 feet 9 inches
Speed on designed load draft	13 knots
Deadweight, designed load draft	10,500 tons
Cargo capacity, bales	470,000 cubic feet
Fuel oil capacity at 38 cubic feet per ton	2,400 tons
Drinking water tanks	29 tons
Reserved feed water	150 tons

Propelling Machinery

Each ship is driven by a Westinghouse cross compound turbine, rated at 4,200 shaft horsepower and 3,600 revolutions per minute, and consisting of two elements—high pressure and low pressure—which drive the single propeller through a common gear. The high pressure element is of the impulse-reaction type, and the low pressure element of the pure-reaction type. Either element can be used independently in case of emergency. An astern turbine, of the

New Shawmut Passenger and Cargo Steamship *Mount Carroll*

impulse type, is incorporated in each element, and the two are arranged for compound operation.

The guaranteed steam consumption is 11.3 pounds per shaft horsepower hour, with dry saturated steam at 200 pounds pressure, and a vacuum of 28 inches. Superheat up to 50 degrees F. can also be used. Special nozzles, which permit an additional flow of steam, are provided so that full power can still be obtained in case either the pressure or the vacuum, or both, fall below normal. The astern turbines will develop 60 percent of the ahead power with full ahead steam flow.

A new form of governor, known as the oil-relay type, is used on these turbines. Its construction is of special interest because a new principle is employed. The steam supply is controlled by a valve which is maintained in its proper operating position by oil under pressure in the manner of the well-known hydraulic relay in combination with a floating lever. This relay is in turn controlled by the movement of a spring loaded valve, which is also controlled by oil under pressure. The pressure in this latter oil system is maintained by a centrifugal pump, mounted on the turbine shaft, and since this pressure varies directly with the speed of the turbine, a very sensitive speed control is obtained.

The gear is of the double reduction type and consists of two high speed gears, one for each turbine element, which drive a single slow speed gear connected directly to the propeller shaft. The speed reduction on the first step is from 3,600 to 520 revolutions per minute, and on the second step from 520 to 90 revolutions per minute.

The thrust bearing, which is an integral part of the slow speed gear, is of the latest Kingsbury type.

The main condenser has an area of 6,000 square feet and will condense 53,000 pounds of steam at 28.3 inches vacuum, with 70 degrees cooling water. Vacuum is maintained by means of air ejectors. The condenser is served by a 7,500-gallon per minute centrifugal circulating pump, driven by two turbines, which are so arranged that either may be used. The condensate is handled by two turbine driven pumps having a capacity of 140 gallons per minute each.

The auxiliary condenser has an area of 1,080 square feet. All of this apparatus is of Westinghouse make.

The *Mount Carroll* and *Mount Clinton* are the fourth and fifth Westinghouse-equipped ships to be owned by the Shawmut Steamship Company. Reports from the earlier vessels show that the gears and turbines with which they are equipped have given excellent service.

Ore and Coal Carriers Chilore and Lebore

20,700 Ton Deadweight Vessels Being Built by the Bethlehem Shipbuilding Corporation, Ltd., for the Ore Steamship Corporation

In the description of the 20,500-ton deadweight, Bethlehem-Frear, combination ore and oil steamers *Marore* and *Steelore*, published in the April issue of Marine Engineering, it was stated that of six combination ore steamers under construction by the Bethlehem Company the last two, namely the *Chilore* and *Lebore*, were combination ore and coal carriers and that a description of the special features connected with their design would follow at an early date.

These two later vessels will be built at the Union Plant of the Bethlehem Shipbuilding Corporation at San Francisco and like their predecessors will be constructed on the longitudinal system of framing. With the exception of the design and construction of the holds, ballast and fuel tanks, cubic capacities, tonnage measurements, and slight increase in deadweight due to about 100 tons less steel, omission of steam-heating coils, reduced pumping capacity, etc., the description of the *Marore* and *Steelore* applies to these vessels and should be referred to if the reader desires a complete description of the quarters, decks, hatches, cargo handling gear, deck and propelling machinery, etc. For convenient reference, however, the full data compilations, corrected where necessary to make them applicable to these vessels, are reproduced.

Although the holds and tanks are of special design and construction, they are distributed over the same length of the vessel, thereby permitting the two ends to correspond exactly with those of the earlier vessels in details of construction. This resulted in great advantage, as many of the plans were thus common to both types of vessels.

Design Requirements

These vessels are to operate between New York or Baltimore and Cruz Grande, Chile, via the Panama Canal and will carry coal south and iron ore north.

In order to insure the greatest commercial success, it was

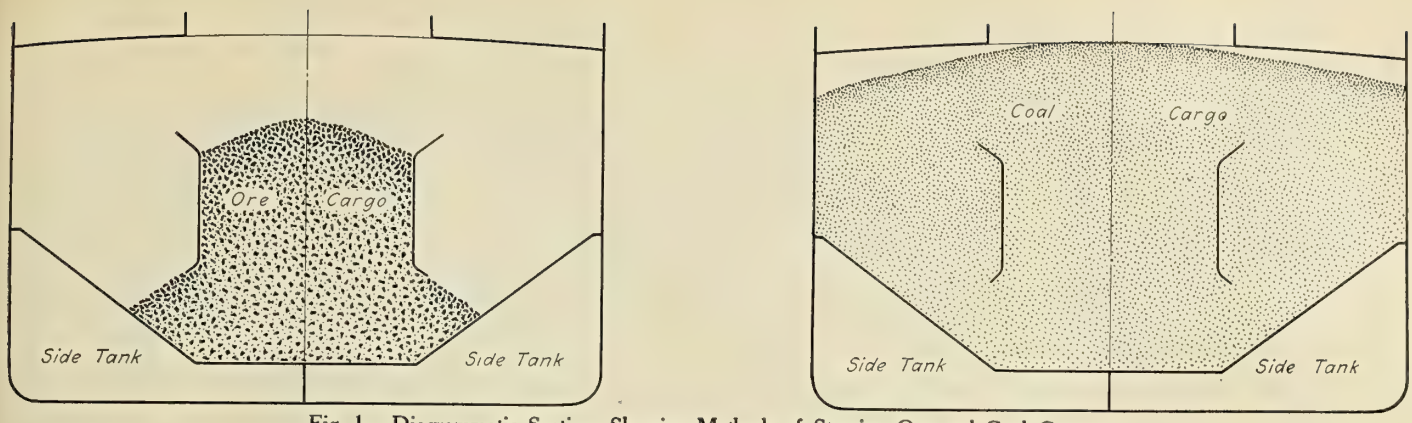


Fig. 1.—Diagrammatic Sections Showing Methods of Stowing Ore and Coal Cargoes

Fig. 2.—Midship Section

Ore and Coal Carriers Chilore and Lebore

General Information

Service: Iron Ore and Coal, Sparrows Point, Maryland, to Cruz Grande, Chile.

Builder: Union Plant, Bethlehem Shipbuilding Corporation, Ltd.

Owner: Ore Steamship Corporation, New York City.

Characteristics

Length, overall	571'-6"
Length between perpendiculars	550'-1"
Breadth, molded	72'-0"
Depth, molded	44'-0"
Draft, loaded, designed	32'-4"
Draft, light, estimated	10'-9"
Block coefficient	0.815
Midship section coefficient	0.989
Longitudinal coefficient	0.826
Speed, loaded, knots	11.5
Cruising radius at 10.5 knots, nautical miles	20,000
Framing	Longitudinal
Class	A-1 American Bureau of Shipping

Tonnages

(In tons of 2,240 pounds)

*Weight of Hull	7,950
**Weight of Propelling Machinery	950
Deadweight Capacity	20,700
Displacement	29,600

(In tons of 100 cubic feet)

Gross register	
Net register	

* Weight of Hull includes Hull Proper, Hull Fittings, Equipment, and Outfit.

**Weight of Propelling Machinery includes Engines, Boilers (Wet), Shafting, Propellers, and Machinery Space Auxiliaries.

Canal Ratings

(In tons of 100 cubic feet)

	Gross	Net
Suez		
Panama		

Equipment

2 Bower Anchors, each	14,105 lbs.
1 Bower Anchor, spare	12,005 lbs.
1 Stream Anchor	5,040 lbs.
1 Kedge Anchor	2,135 lbs.
Chain Cable, 330 Fms	2⅞" dia.
Stream chain, 105 Fms	5½" cir. steel wire
Towline, 140 Fms	7" cir. steel wire
Hawsers (3), 90 Fms	8½" cir. manila
Warps (3), 90 Fms	7½" cir. manila

Rudder

Area	244 sq. ft.
Dia. Stock	15"
C. Press. abaft C. L. pintles	4'-8"

Complement

Deck officers	5
Deck crew	19
Engineer officers	7
Engineer crew	12
Purser's and steward's department	10
Total officers and crew	53

Handling Equipment

	No.	Type	Capacity	Length
Masts	2	Pole		129'-0" above deck
Derrick posts	10	Tubular	3 Ton	32'-0" high
Booms	18	Pine	3 Ton	36'-0"

Deck Machinery

Steering Gear....Screw gear type, 16"x12"
Windlass..(1) Triple spur geared, 13"x13"
Capstans
Winches, cargo, (10) 8¼"x10" compound geared (1) 9" x 12"
Winches, mooring, compound geared, (6) 10"x12"

Life Saving Equipment

	No.	Type	Length
Lifeboats	4		26'-0"
Workboat	1		16'-0"
Liferaft	1	25 persons	

Propelling Machinery

Boilers

Number	3
Type	Scotch, single ended
Length	12'-0"
Diameter	17'-6"
Furnaces, per boiler	4
Fuel	oil
Draft	Forced
Total heating surface, square feet	12,861
Total furnace volume, cu. ft.	2,226
Superheat, degrees F	200
Working pressure, lbs. per sq. in	220
Normal fuel consumption:	
Per day, tons	43
Per horsepower hour, pounds	0.9
Normal steam production:	
Per hour per pound of fuel	15 lbs.
Total per hour	54,000 lbs.

Engines

Number	2
Type, Bethlehem-Curtis turbines, Falk single reduction gear	
Horsepower, normal	4,500
Horsepower, maximum	5,000

Propellers

Number	2
Type	Solid, three bladed
Weight, each, lbs.	16,000
Diameter	15'-8"
Pitch	12'-8"
R. P. M.	105
Projected area, square feet	56.85
Developed area, square feet	65.65

Auxiliary Machinery

Machinery Space

Condensers, main, 2.....4,000 sq. ft.
Evaporators.....(2) 30 tons each
Condensers, auxiliary, 1 .....1,000 sq. ft.
F. O. Starter heater
F. O. Meter
Feed water heater (1).....Multiflow
Fuel oil heaters (3)
1 Grease extractor.
4 Lubricating oil coolers.
1 Forced draft blower, 20" fan, 2-8"x16" vertical engines.
Pumps:
2 Main circulating, 14" centrifugal, 9 x 8 reciprocating engine.
2 Main air, 9½ x 17 x 15 independent dual with augmentor jets.
1 Combined auxiliary air and circulating 12 x 14 x 14 x 12.
1 Pair main feed, 15½ x 11½ x 24 vert. simp.
4 Forced lubricating oil, 7 x 8 x18 vert. simp.
1 Fire and general service, 10½ x 8 x 22 vert. simp.
1 Engine room bilge 7 x 8 x 18 vert. simp.
1 Sanitary, 1 bilge attached, each 6½ x 7½ inclined simp.
1 Fresh water, 4½ x 5 x 12 vert. simp.
1 Sanitary, 4½ x 5 x 12 vert. simp.
2 Water circulating for lubricating oil cooler, 9 x 10 x 21 vert. simp.
1 F. O. transfer, 7 x 8 x 18 vert. simp.
2 F. O. service, 7¼ x 5 x 10 horiz. simp.
1 Ballast, turbo-centrif., 100 h. p. turbine.
2 Bilge and ballast, 10 x 14 x 16 duplex.
1 Donkey boiler feed, 5 x 3½ x 6 vert. simp.
1 Donkey boiler, Scotch, 1 furnace, 317 sq. ft. H. S.

Refrigerating Machinery

2 2-ton ammonia direct expansion machines.

Electric Equipment

Generators 2.....20 k. w., each driven by 9" x 7" vertical reciprocating engine.

Holds

No.	Length	Hatches (No.)
1	78'-0"	2
2	50'-0"	1
3	80'-0"	2
4	80'-0"	2
5	70'-0"	2

Capacities

Cargo Space

Compartment	Cu. Ft.
Hold No. 1	208,535
Hold No. 2	121,654
Hold No. 3	202,226
Hold No. 4	200,960
Hold No. 5	178,481
Total	911,856

Store Rooms

Compartment	Grain Cu. Ft.	Bales Cu. Ft.
Lower 'tween decks 61-4	23,228	22,222
Upper " " 61-4	16,477	15,547
" " " 64-stem	9,166	8,463
Lower " " P. 17-23	5,694	5,102
" " " S. 15-23	7,135	6,382
Total	61,700	57,716

Refrigerated Space

Compartment	Cu. Ft.
Meat room	1,418
Vegetable Room	1,245

Bunkers

Compartment	Gallons	Tons
No. 1 side tank, 57-61	141,282	497
No. 5 " " 29-32	132,854	467
No. 5 " " 25-29	165,532	582
Fuel tank 24-25	223,053	785
" " 23-24	114,234	402
Deep tank 61-64	226,734	798
Total	1,003,680	3,531

Tanks

Compartment	Tons F. W.	Tons S. W.
Engine room D. B.	50	
Boiler room D. B.	198	
On main deck aft	37	
Aft Peak	313	
Fore Peak		662
No. 1 tank P. & S. 53-61		920
No. 2 " " 48-53		998
No. 3 " " 40-48		1,601
No. 4 " " 32-40		1,601
No. 5 " D. B. 23-32		319
Aft Peak		322
Deep tank 61-64		866
No. 1 side tank 57-61		540
No. 5 " " 29-32		407
No. 5 " " 25-29		632
Total	598	8,968

necessary to evolve a design which would not only provide for a full deadweight cargo of either ore or coal, due consideration being given to the proper stowage of such a large tonnage of ore in an ocean-going steamer, but would permit of the quickest possible turn-a-round. To accomplish this it was of prime importance that all of the ore and coal be loaded and discharged through the same hatches, that while loading both kinds of cargo be self trimming, that during discharge the cargo carried in the wings would automatically trim to the center under the hatches and that the dense ore cargo would not only be distributed over the greatest possible length of the vessel to reduce the sagging stresses but so stowed that its center of gravity would be as high as possible to minimize the rolling stresses.

Arrangement of Cargo Holds

Reference to the midship section and diagrams (Figs. 1 and 2) will perhaps convey a clearer idea than a lengthy description of how these various features were combined to produce what it is believed will prove an ideal combination ore and coal steamer. It will be noted that there are two fore and aft trimming bulkheads spaced so that there is a central ore hold 26 feet wide. The trimming bulkheads extend the full length of the cargo holds so that the ore can both be distributed over the greatest possible length and also be so confined transversely that its center of gravity will be at a suitable height. Attention is also called to the deep continuous openings at both the top and bottom of the trimming bulkheads. These openings, in connection with the sloping wing tanks at the bottom, not only allow the coal cargo during loading to flow freely over the top into the wings but also to trim to the center during the operation of discharging.

Features of Design

The trimming bulkheads are very substantially constructed and supported. In fact they are sufficiently strong to support the full weight of ore cargo on a 90-degree angle of heel, which it is needless to say could not be experienced.

The cargo holds are subdivided into five compartments by watertight transverse bulkheads.

The question of repairs incident to carrying ore improperly stowed both on the Great Lakes and on ocean voyages was given much thought in the design of both the ore-oil steamers and the ore-coal steamers. Many vessels carrying rails, pig iron and similar cargoes have met with serious damage on account of a reasonable proportion of the heavy cargo not being distributed in the 'tween decks. Many ingenious methods were resorted to, in the early wooden vessels carrying Spanish copper and iron ore, to raise the center of gravity of the cargo. This was accomplished sometimes by carrying empty barrels in the wings. In other cases the center of gravity was raised by fitting a false deck of wood very heavily shored and this was often made more effective by fitting two fore and aft bulkheads of wood spaced about a half breadth from the center on each side and substantially braced. It was found that vessels carrying ore in this manner were subject to no greater stresses or required no more repairs than when carrying general cargoes in the ordinary way.

The six large combination ore carriers are designed on correct principles in this respect and it is confidently believed that the carriage of iron ore stowed as it is in these vessels will create no greater stresses on the vessels as a whole or locally on any of the members than experienced with general cargoes properly stowed. The wear and tear due to loading and discharging the ore has been provided for by exceptionally heavy plating and framing forming the floor of the holds as compared with lake ore carriers. Notwithstanding the elimination of all the traditional objections connected with the ore carrying trade and a strict compliance with the laws of nature, the stresses affecting the vessels as a whole and every member locally have received a most thorough and exhaustive study. With a view to taking no chances and securing every possible insurance against these vessels being laid up for repairs, an excessive amount of steel has been introduced into their construction.

Ratio of Deadweight to Steel

The deadweight in tons divided by the steel in tons on the ore-oil steamers ranges from 2.78 to 2.88 and on the ore-coal steamers is 2.95. It is common for tankers to carry from 3.25 tons deadweight and up per ton of steel and freighters often carry from 3.4 tons and in some cases as high as 4.3 tons deadweight per ton of steel. When it is considered that there is little control over the stowage in ordinary vessels and that the stowage, especially of the iron ore, is absolutely and automatically controlled in the combination ore steamers, the advantages of the design become obvious.

The following table, giving some particulars of a number of vessels and the deadweight carried per ton of steel, should prove of interest in connection with the relatively large tonnage of steel used in the construction of these excptionally strong vessels.

If all the above vessels with the exception of the Lake ore steamer were reduced to a common block coefficient, the relative quantity of steel in the Bethlehem ore steamers would appear greater. The difference in deadweight to steel between the *Bethore* and the *Steelore* is due to the elimination of some steel which the builders objected to in the first two vessels and does not in any way detract from the strength.

The old *Bethore*, which is a vessel of exactly the same type as the present ore-oil steamers except that one additional deck is fitted, shows a much higher efficiency so far as steel to deadweight is concerned. The plans for this vessel were approved by one of the classification societies and it was considered an exceptionally strong vessel; at the same time there

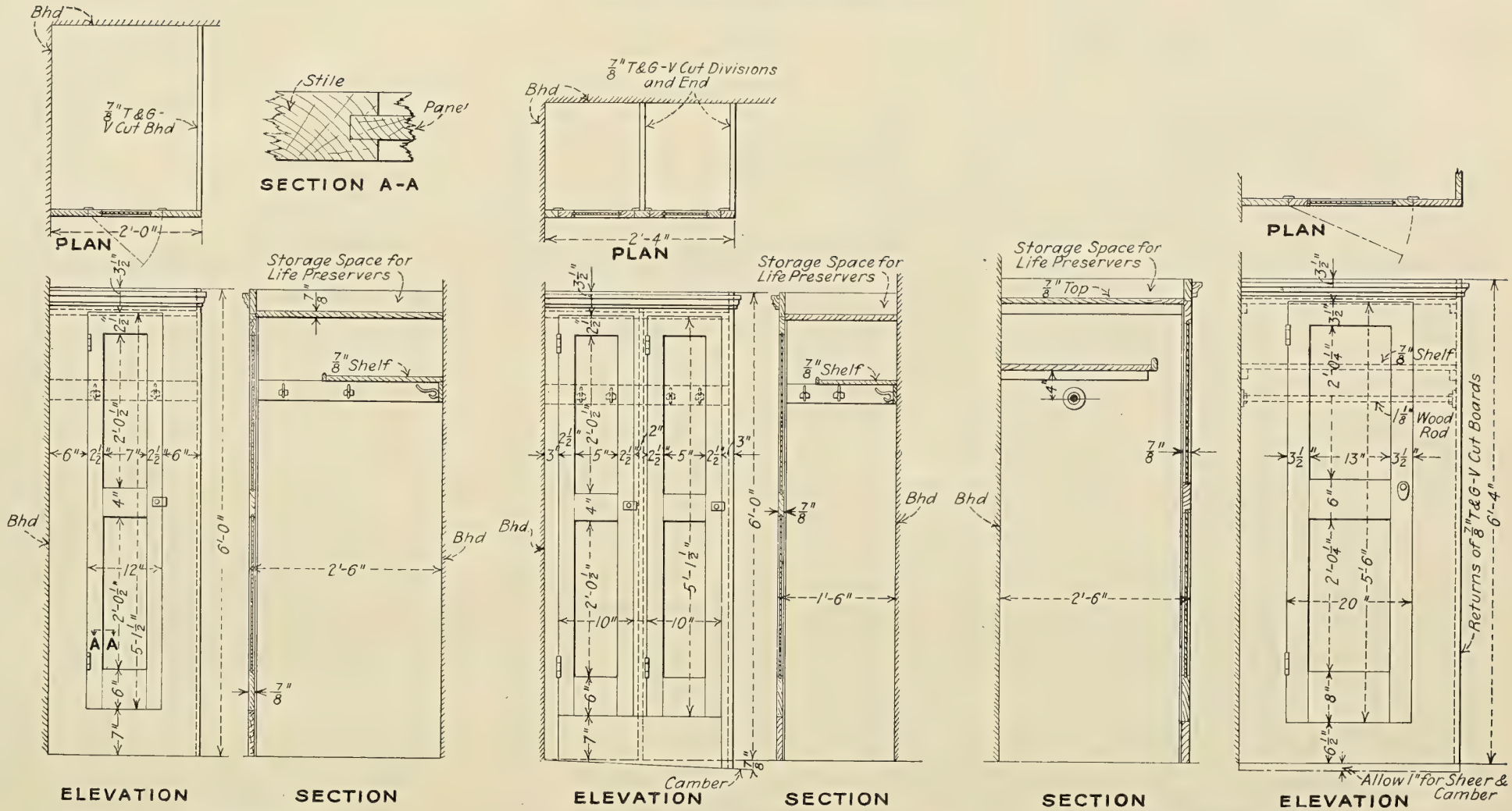
(*Concluded on page* 413.)

Table Showing Deadweight Carried Per Ton of Steel for Various Vessels

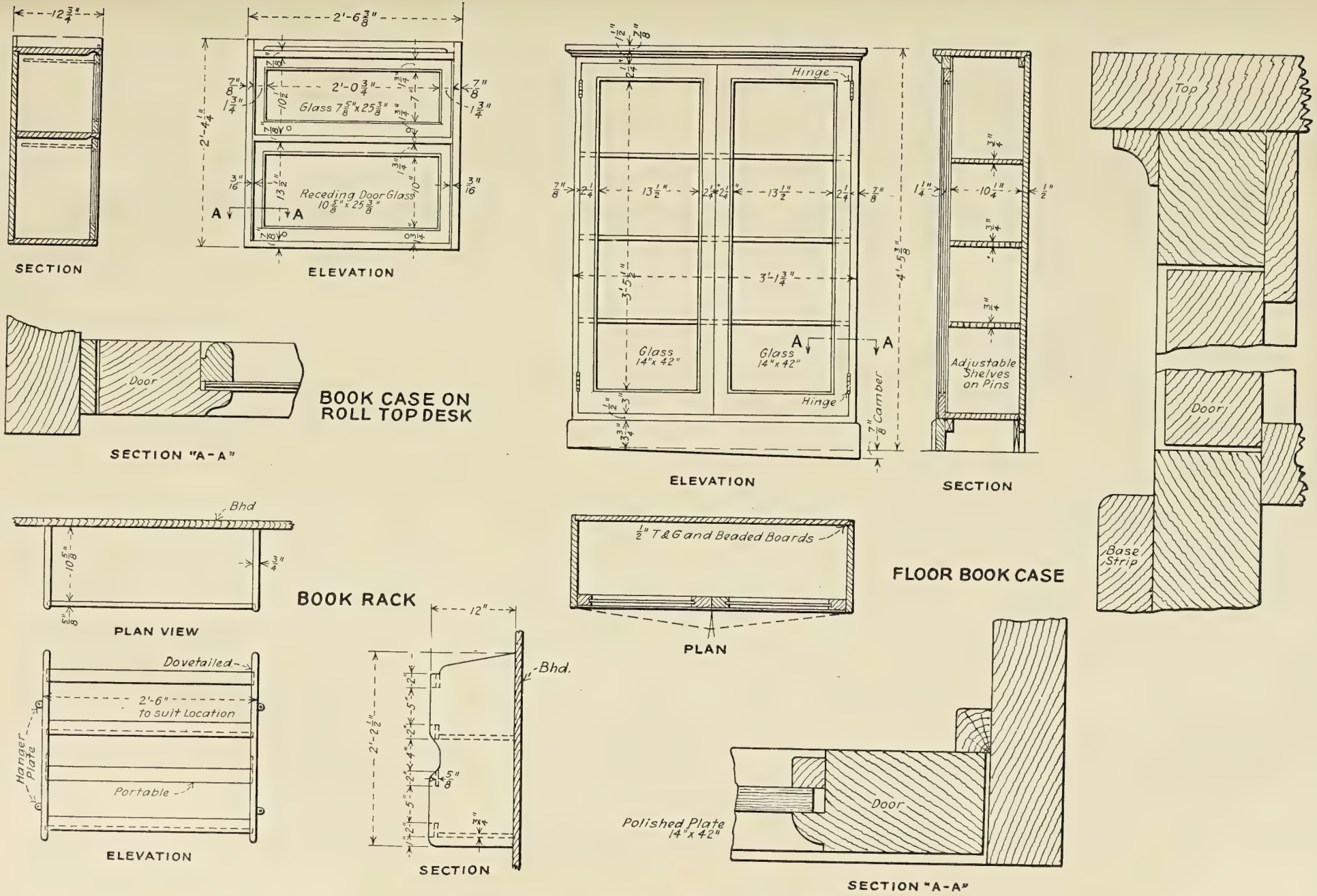
	New *Bethore* Ore and Oil Steamer	*Steelore* Ore and Oil Steamer	*Chilore* Ore and Coal Steamer	Old *Bethore* Ore and Oil Type	*Cubore* Ore and Coal Steamer	Lake Ore Steamer	Newport News 20,300 Deadweight Tanker	*San Fernando* Tanker	*F. W. Woller* Tanker	*War Knight* Freighter	*Eclipse* Freighter
Length	550	550	550	500	450	580	550	530	500	410	440
Breadth	72	72	72	66	57	58	75	69	68′-6″	56	56
Depth, Molded	44	44	44	42	37	32	43′-3″	42′-3″	38	41	38
Draft	32′-4″	32′-4″	32′-4″	31′-1″	27′-3″	19′-3″	30′-0″	30′-8¼″	27′-3″	30′-6″	28′-7¾″
Block Coefficient	.815	.815	.815	.8065	.795	.868	.80	.805	.80	.799	.797
Displacement	29,600	29,600	29,600	23,723	15,865	16,060	28,270	25,800	21,275	15,925	16,000
Steel	7,300	7,100	7,000	5,200	3,273	3,929	6,025	5,666	4,663	3,082	2,800
Deadweight	20,320	20,500	20,700	17,200	11,669	11,451	20,300	18,550	15,000	11,823	12,000
$\frac{DW}{Steel}$	2.78	2.88	2.95	3.3	3.56	2.91	3.36	3.27	3.21	3.83	4.3

Ship Joiner Plans

LOCKERS, WARDROBES AND BOOK CASES



Details of Construction of Lockers and Wardrobe



Details of Construction of Book Rack and Book Cases

Steel and Iron for Shipbuilding Purposes

By Horace Holden Thayer*

This is one of a series of articles containing information regarding shipbuilding materials and their uses that is not readily obtainable from shipbuilding handbooks and other generally available sources. The articles are not intended to be a complete exposition of the subject but will be found to contain items of value to the various classes of workers who have to deal with these materials from the materials point of view.

STEEL and iron are the most important materials entering into the construction of commercial vessels of all classes—steel, composite, wood or concrete. Therefore they merit first consideration among such materials. Although not generally so recognized, a wood steamship is essentially a steel industry proposition; and the cost of the iron or steel fastenings in a wood ship alone constitutes a large percentage of the cost of the hull materials.

Physical Properties

The physical properties of the steel or iron, whether for ship, boiler or machinery use, are specified in classification society rules, and where the vessel is classed they are fully taken care of by these rules and the inspection and tests that are made in conformity with them. So they need not be dwelt upon here. Even where a vessel is not classed, it is by all means advisable to adopt classification society standards or some other good standards for the items that, on classed vessels, have to be up to certain specified requirements. The properties of boiler steel and iron are specified by the Rules and Regulations of the United States Steamboat Inspection Service for all vessels under their jurisdiction.

Chemical Properties

The chemical compositions of steel and iron for structural parts of the hull or machinery, for shafting, connecting rods and other highly stressed parts, for springs, for screw stock, for alloy steel and tool steel of different grades, for cast steel, for the general run of iron castings and for cylinder castings, are furnished by the engineering handbooks, which also give information regarding heat treatments where such are necessary. Large manufacturers of machinery also have their standards for the chemical compositions and heat treatments of the materials that they have to work up into the finished product.

Requirements

During the war the classification societies waived their individual requirements to the extent of accepting ship steel that would conform to specifications A-12-16 of the American Society for Testing Materials. As it may be considered desirable to adopt these specifications where strict adherence to classification requirements is not necessary, and as they may not be familiar to the readers of this paper, their principal features are here given:

Tensile strength = 58,000 to 68,000 pounds per square inch.

Minimum yield point, determined by the drop of the beam of the testing machine = ½ of tensile strength.

$$\text{Minimum elongation in 8 inch, percent} = \frac{1{,}500{,}000}{\text{tensile strength}}.$$

For material over three-quarter inch thick a deduction of 1 percent from the percent given by the above formula is made for each increase of one-eighth inch in thickness above three-quarter inch, with 18 percent as the minimum. For material one-quarter inch thick or less the elongation is to be measured on a gage length of 24 times the thickness of the specimen.

The bend test specimen is to bend cold through 180 degrees without cracking on the outside of the bent portion. Material three-quarter inch thick or less is to be bent around a pin of the same diameter as the thickness of the specimen; material over three-quarter inch up to and including one and one-quarter inch thick is to be bent around a pin of a diameter 1½ times the thickness of the specimen; and material over one and one-quarter inch thick is to be bent around a pin whose diameter is twice the thickness of the specimen. Other test requirements of these specifications are in general those adopted by classification societies and others to assure the obtaining of representative specimens and fair tests.

It will be noted that the tensile test limits are almost identical with those adopted by the principal classification societies for steel that is to be flanged when cold; and that for the general run of plates and sections the low and high limits are about 4,000 pounds lower than the classification society limits. It will also be noted that the method of specifying the minimum elongation is a departure from classification society practice.

Steel Not Subject to Test

The advisability has been referred to of specifying standard properties for such items of steel or iron in unclassed vessels as would be governed by classification requirements, if the vessel were classed. There are, however, in all vessels many items where questions of structural strength or other special features are not involved and which even on classed vessels do not have to be up to the standards of items that have these special requirements to meet.

The steel companies refer to any steel that is not tested and may have any tensile strength from very high to very low as tank steel. It is their basis steel and sold at the base price. If structural steel is ordered without special test requirements it will genrally have a tensile strength ranging from 55,000 to 68,000 pounds per square inch, though there is no guarantee as to this. With orders for this steel, however, the steel companies will usually, if desired, furnish free of charge a record of their own mill test of the material. The price is the same as for the tank steel. Where steel is ordered to meet classification society inspection and test requirements, the price is still the same, except for special grades, and the only extra charge is that made by the classification society.

A very considerable percentage of steel hull material on a classed vessel can be ordered of untested steel, at a corresponding saving in the fees for test and inspection of the material, and also a saving in time. Some of the items in the testing of which the classification societies are not interested, unless the construction is something out of the ordinary, are listed below. For such items it is recommended that structural steel be specified rather than tank steel and that the mill test of the material be requested.

Plates

Screen bulkheads.
Chain locker when not part of main bulkhead.
Dynamo flats, etc.
Engineer's store room and similar enclosures.

* Member of Rossell & Thayer, Naval Architects and Marine Engineers, Philadelphia, Pa.

Coal chutes.
Trunks to store rooms.
Bilge keels.
Bulkhead and watertight floor shell liners.
Miscellaneous liners.
Uptakes and support brackets.
Miscellaneous bulkheads and partitions above the upper deck.
Cargo mast or derrick platforms or tables.
Bow chocks.
Hatches on poop, bridge and forecastle and superstructure decks.
Houses on poop, bridge and forecastle and superstructure decks.
Coaling hatches on casings.
Fidley top.
Engine, boiler and galley skylights.
Ventilators, except coamings.
Stack.
Independent fresh water tanks.
Gravity tanks.
Checkered plates for engine and boiler room floors.

Shapes

Screen bulkhead stiffeners.
Chain locker when not part of main bulkhead.
Dynamo flats, etc.
Engineer's store room and similar enclosures.
Coal chutes.
Trunks to store rooms.
Hawse and chain pipe collars.
Tank top manhole stiffening rings.
Bilge keels.
Uptake angles and supports.
Miscellaneous bulkheads and partitions above the upper deck.
Cargo mast or derrick platforms or tables.
Mast hull angles and deck rings.
Bulwark rail and braces.
Batten bars for hatches.
Hatches on poop, bridge and forecastle and superstructure decks.
Houses on poop, bridge and forecastle and superstructure decks.
Bow chocks.
Coaling hatches on casings.
Fidley top.
Engine, boiler and galley skylights.
Ventilators.
Stack.
Independent fresh water tanks.
Gravity tanks.

Half rounds, half ovals, and flat bars for moldings, liners, fenders, etc., are not subject to classification inspection and test.

Other Hull Plate Considerations

When dealing with hull plates from the standpoint of materials, the following considerations present themselves as being of importance.

Plates have to be laid off in such lengths and widths as can be readily obtained from the rolling mills. The maximum length that can be rolled by a majority of the smaller mills runs from 30 feet for plates ⅜ inch by 60 inches to 16 feet for plates ¾ inch by 72 inches; although a few of the larger mills can greatly exceed these figures. Care has also to be taken that plates which require rolling are not ordered too long to go into the rolls and that furnaced plates are not ordered too large to go into the furnace.

Steel companies having universal mills can furnish plates of any length within width limits of about eight inches to forty-eight inches and limits of thickness of about one-quarter inch to two inches. They are accepted by the classification societies subject to the usual test requirements. These plates, however, have rounded edges and, if required for use where one or both edges have to be calked, they have to be ordered sufficiently wide to allow of planing or chipping off this rounded edge. Universal mill plates are furnished at the base price.

The classification societies either place a minimum limit on the length of a shell plate of a certain width or require special strength in the riveting of the butts.

Joggling of shell plates or deck plates to eliminate the liners that would otherwise be required in way of the outer strakes results in rapid corrosion of the plate along the joggle, and is therefore not a good practice. Furthermore, many repair yards do not have facilities for proper renewal of joggled plates.

On account of the extras charged by steel companies for sketch plates it is in many cases desirable to order rectangular plates, to be cut to shape later at the shipyard. This is particularly true of beam knees and brackets generally, which can be laid off in pairs on rectangular plates in a manner to have very little waste of material.

A convenient and accurate method of making up a schedule of shell plating is to have the plating completely laid off on a wood model and a scale of from one-fourth inch to one-half inch to the foot, according to the size of the vessel, to trace off the plates in strakes on strips of tracing paper; and to measure the plates from these strips.

Other Hull Shape Considerations

When dealing with hull shapes from the standpoint of materials, the following considerations present themselves as being of importance:

Bulb angles are more economical of material than plain angles.

Where channel framing can be six inches or smaller, bulb angles should be substituted in tanks, double bottoms or other compartments designed to carry oil, because the inner flange of the channel interferes with the proper holding on of the rivet.

Structural channels except in sizes fifteen inches or larger are not satisfactory for ship use generally on account of the narrow flange width and the great slope of the inner face of the flange.

Plates should be substituted for angles that require to be shaped to a very open bevel, as the bevel cannot be worked right to the heel of the angle.

The number of different shapes and sizes should be reduced to a minimum. This will result in a saving of time in changing rolls at the mill, work toward a reduction in the amount and variety of stock material to be kept on hand at the shipyard and lessen the liability of items having to await the accumulation at the mill of other orders for a sufficient amount of similar sizes to warrant a rolling. This subject was considered of such importance during the recent war that an examination was made of the shape material schedules of over 1,500 vessels building for the United States Shipping Board, having a deadweight carrying capacity of 10,302,150 tons and requiring 1,100,651 short tons of steel shapes. It was found that over 400 different sizes and weights of shapes were specified, even assuming thicknesses of the same size of any shape not differing more than 2½ percent as being the same. It was also found that many weights were specified in lots of less than 100 pounds per hull. In one design that was produced at several shipyards the number of different sizes and weights of shapes adopted by the builders ranged from 45 to 73; in another design also produced at several shipyards, from 29 to 45. The yards using the greater number of sizes and weights do not appear to have made any gain in deadweight or effected any appreciable saving in steel thereby. In fact in one of the above mentioned designs, investigated by the writer, where the propelling machinery and other important factors are identical, the light ship in which 45 different sizes and weights of shapes were used displaced 40 tons more than the light ship whose builder used 29 different sizes and weights. An analysis of twelve representative schedules made by the technical department of the Emergency Fleet Corporation indicated that by concentrating on a proposed standard list of shapes which comprised 107 different sizes and weights, and without serious change in existing details or templates, the average number of sizes and weights of shapes per hull could be reduced to about 75 percent of their variety as scheduled, with an increase in the average weight of steel of less than one ton per hull. The list of ship channels, except a popular 6-inch by 3½-inch by

15-pound size, and the list of bulb angles, were based on British standards, which are more economical of material and therefore more desirable than have been generally produced by our rolling mills in the past.

In the latter part of 1918 this proposed standard list was submitted to the representative steel shipyards and rolling mills with request for comment and criticism; and as a result a somewhat modified list, shown in Table 1, was adopted as a standard. Furthermore the steel makers agreed to alter their ship channel and bulk angle rolls at as early a date as possible to enable them to roll these sections in conformity with the British standards.

It will be noted that there are 112 different sizes and weights in this standard list; and it is a very good one to use as a basis, making the minimum number of departures from it necessary to meet design requirements and rolling mill facilities. The T-bar was included in the standard list on account of its use for bilge keels and bulkhead bounding bars, and the Z-bar was included on account of its convenience as a rabbet for hatch covers.

TABLE 1

EQUAL LEG ANGLES

Size	Thickness Inches	Wt. per Ft. Lbs.	Size	Thickness Inches	Wt. per Ft. Lbs.
6 x 6	.75	28.7	3½x3½	.625	13.6
	.6875	26.5		.5625	12.4
	.625	24.2		.50	11.1
	.5625	21.9		.4375	9.8
	.50	19.6		.375	8.5
	.4375	17.2		.3125	7.2
	.375	14.9			
			3 x 3	.50	9.4
5 x 5	.625	20.0		.4375	8.3
	.5625	18.1		.375	7.2
	.50	16.2		.3125	6.1
	.4375	14.3		.25	4.9
	.375	12.3			
			2½x2½	.3125	5.0
				.25	4.1
			1¾x1¾	.1875	2.12

UNEQUAL LEG ANGLES

6 x 3½	.75	22.4	5 x 3	.6875	17.1
	.6875	20.6		.625	15.7
	.625	18.9		.5625	14.3
	.5625	17.1		.50	12.8
	.50	15.3		.4375	11.3
	.4375	13.5		.375	9.8
	.375	11.7		.3125	8.2

BULB ANGLES

Size	Thickness of Longer Leg, Inches	Wt. per Ft. Lbs.	Size	Thickness of Longer Leg, Inches	Wt. per Ft. Lbs.
10 x 3½	.675	33.2	7 x 3½	.525	19.9
	.625	31.1		.475	18.3
	.575	29.1		.425	16.8
	.525	26.9		.40	16.1
	.50	25.9			
			7 x 3	.45	16.7
9 x 3½	.625	28.3		.40	15.3
	.575	26.4		.375	14.6
	.525	24.5			
	.475	22.7	6 x 3	.475	15.5
	.45	21.8		.425	14.1
				.375	12.8
				.35	12.2
8 x 3½	.55	23.1			
	.50	21.3			
	.45	19.6			
	.425	18.8			

SHIP CHANNELS

Size	Web Thickness Inches	Wt. per Ft. Lbs.	Size	Web Thickness Inches	Wt. per Ft. Lbs.
12 x 4	.825	48.8	9 x 3½	.65	31.5
	.725	44.7		.55	28.5
	.625	40.6		.45	25.4
	.525	36.5		.40	23.9
	.475	34.5			
			8 x 3½	.525	25.4
12 x 3½	.70	41.1		.475	24.1
	.60	37.0		.425	22.7
	.50	32.9		.375	21.3
	.45	30.9			
			7 x 3½	.40	20.2
10 x 3½	.575	31.6		.35	19.0
	.475	28.2		.30	17.8
	.425	26.5			
	.375	24.8			
			6 x 3½	.35	15.0

TABLE 1—*Continued.*

STRUCTURAL CHANNELS

Size	Web Thickness Inches	Wt. per Ft. Lbs.
15 x 3½	.818	55.0
	.72	50.0
	.622	45.0
	.524	40.0
	.426	35.0
	.40	33.0
TEES		
6½ x 6½	.45	19.8

I BEAMS

Size	Web Thickness Inches	Wt. per Ft. Lbs.
24 x 7	.50	80.0
20 x 7	.60	80.0
6¼	.50	65.0
18 x 6	.555	60.0
	.46	55.0
15 x 5½	.41	42.0
12 x 5½	.46	40.0
10 x 4¾	.31	25.0
8 x 4	.27	18.0
HATCH ZEE (Tyzack)		
2½	.50	13.6

Order of Shipment of Hull Material

There is sometimes considerable difficulty in obtaining first from the mills the material on any order that is desired first; and shell or keelson plates are found to be not available when needed, while hatch and skylight material has been delivered in abundance. In fact there have been occasions when the keel plates were among the last to reach the shipyard. This situation can be avoided by ordering for first shipment those items that are needed first; and the following schedule will be found to be a good general guide for such ordering:

First Shipment

Keel plates and shapes.
Centerline keelson plates and shapes.
Side keelson plates and shapes.
Margin plates and angles.
Tank top plates and shapes.
Floor plates and shapes.
Bottom shell plates.
Bottom shell liners.
Stem and stern frame.

Second Shipment

Bilge floor plates and angles.
Bilge gusset plates.
All frames and brackets.
Web frame plates and shapes.
All hold bulkhead plates and shapes.
Shaft tunnel plates and shapes.
Hold stringer plates and shapes.
Hold pillar plates, shapes and bars.
Hold girder plates and shapes.
Watertight flat plates, angles and beams.
Second deck beams and brackets.
Second deck plates and angles.
Panting beams and brackets.
Machinery foundations, etc.
Remainder of shell plating and bulwark, and liners and moldings.
Bilge keel plates, shapes and bars.
Rudder plates and shapes.

Third Shipment

Between deck pillars, plates, shapes and bars.
Between deck girders, plates and shapes.
Upper deck beams and angles and brackets.
Upper deck plates and angles.
Bridge, forecastle and poop deck beams and brackets.
Bridge, forecastle and poop deck plates and angles.
All casings and houses, plates and shapes.
Mast, boom and king post, plates and shapes.
Fresh water tank plates and angles.

Boat skid beams and brackets.
Hatch coamings and webs, plates and brackets, shapes and bars.
Skylight and companion plates and angles.
Winch platform, plates and shapes.
Bridge plates and shapes.
Checker plates, etc.

The Amount of Hull Steel in a Steel Vessel

The determination of the amount of steel plates, shapes, bars and rivets in a steel vessel is important from a materials' standpoint as well as from other standpoints, and many formulæ have been devised for arriving at it. For vessels of the same type with little variation in detail features of the design, formulæ with coefficients based upon the weight of steel in one of the vessels will give a close approximation to the weight of steel in the similar vessels; and the simpler the formula the better. The attempt to produce a formula that will apply to dissimilar vessels results in greater complication of the formula and the amounts of steel determined by it must of necessity, outside of a narrow range, be only approximations to the actual amount. The approximation approaches the actual in proportion as the vessel dealt with approaches in similarity the vessel from which the coefficient used in the formula was derived. This can be readily seen by a study of Table 2, which includes only a few of the many types of vessels.

	Coefficient for Formula $\text{Wt.} = \text{Coeff.} \times \frac{L \times B \times D}{100}$
13 oil tankers	.46 to .65
4 oil tank barges	.48 to .54
25 double bottom cargo steamers	.34 to .52
16 single bottom steamers	.31 to .44
28 steamboats	.24 to .49
7 steam yachts	.24 to .44
4 schooner yachts	.17 to .23
7 double ended ferryboats	.32 to .44
11 tugboats	.34 to .55
6 miscellaneous barges	.35 to .51

Column 7 shows an attempt to eliminate one factor of difference by using a corrected depth that makes allowance for variations in sheer and erections. In this formula

$$Dc = D + \frac{\text{Sum of bow and stern sheers}}{6} + \frac{\text{length of P. B. \& F. x ht. of P. B. \& F.*}}{\text{Length of vessel between perps.}}$$

* Length of Poop, Bridge and F'c's'tle by height of Poop, Bridge and F'c's'tle.

For vessels that are similar except for differences in the sheer and erections this formula is preferable to that of column 6, but nearly as much discretion has to be used in the selection of a coefficient as when using the more simple formula.

TABLE 2

No.	(1) Attained Deadweight With Scotch Boilers and Reciprocating Engines—Tons	(2) Type	(3) Framing	(4) Invoice Steel in Short Tons, Assuming 10% for Scrap	(5) Coefficient for Formula $Wt. = C \times D. W.$	(6) Coefficient for Formula $Wt. = C \times \frac{L \times B \times D}{100}$	(7) Coefficient for Formula $Wt. = C \times \frac{L \times B \times D c}{100}$	(8) Coefficient for Formula $Wt. = C \times \frac{L \times B \times D c}{100} \times \frac{1 + b}{2}$	(9) Coefficient for Formula $Wt. = C \times \left(\frac{L(B+D)}{1,000}\right)^{1.3}$
1	9374	Shelter Dk. with Short Poop and F'c'stle.	Longt.	2840	.303	.386	.346	.389	13.6
2	9695	Shelter Dk. with P. B. & F.	Longt.	3020	.312	.398	.341	.383	14.2
3	8541	Three Island	Transverse	3340	.391	.507	.407	.452	16.6
4	3525	Three Island	Transverse	1360	.386	.516	.432	.479	19.5
5	10000	Tanker-Poop Short Bridge & F'c'stle.	Longt.	3920	.392	.480	.415	.461	16.1
6	7520	Tanker-Poop Short Bridge & F'c'stle.	Longt.	3140	.418	.520	.437	.489	17.6
7	....	Ocean Tug Steel House	Transverse	275	....	.425	.387	.545	17.6
8	....	Harbor Tug Steel House	Transverse	160	....	.552	.510	.718	24.6

The relation between the weight of steel and the deadweight of the vessel is shown in column 5 of Table 2. It is never anything more than an approximation; but for vessels of any particular type and service, it is a measure of the economy of their proportions from the materials standpoint.

The most generally used formula is that of column 6, figuring the weight of steel as proportional to the product of the length between perpendiculars, the breadth molded and the depth molded to the top complete deck. It will be noted that, while the coefficients, for vessels of a type are quite close together, the large tanker has a lower coefficient than the small dry cargo boat. An idea of the great range of coefficients when using this formula may be obtained from the following tabulation, which has been made up from a considerable number of actual material order schedules and detailed weight estimates. The coefficients are for the weight of invoice steel in tons of 2,000 pounds.

A still further refinement is shown in column 8 where an attempt is made to take care of the differences in the fullness of the vessels by introducing the factor

$$\frac{1 + \text{the block coefficient}}{2}.$$

The result is a formula which is still far from being of wide application without variation of the coefficient. However, if we compare the shelter deck longitudinally framed vessel No. 1 with the poop, bridge and f'c's'tle, transversely framed vessel No. 3 we find that whereas with the formula of column 6, the difference between the coefficients is about 31½ percent of the low value, with the formula of column 7

it is only 17½ percent, and with the formula of column 8 only 16 percent. A reasonably close approximation to the weight of steel in a cargo vessel of usual construction and proportions can be obtained by the use of this formula and a coefficient based upon actual weights of dry cargo vessels with transverse framing designed to meet the requirements of the American Bureau of Shipping as a group by themselves, similar vessels designed to meet the requirements of Lloyd's Register of Shipping as another group, longitudinally framed vessels as other groups, etc.

Column 9 illustrates the application of another formula that is sometimes used, the dimensions being those of the preceding formulæ.

Still another method of determining the weight of steel is to figure up from the midship section plan the weight per foot of length of vessel of all structural items below the weather deck that extend for at least one-half the vessel's length, including stanchions, bilge keels, moldings and fenders, and to multiply this by the length and by a coefficient. This coefficient for short tons of invoice steel will be in the neighborhood of 1.5, but like those listed in Table 2 varies considerably. The less the material used in the ends of the vessel and for purposes other than strength requirements, the lower will be this coefficient.

The amount of steel shown in Table 2 is taken for convenience as 110 percent of the net steel and any of the coefficients can be reduced to those for displacement tons of net steel by multiplying by the factor $\frac{2{,}000 \times 100}{2{,}240 \times 110}$.

Proportion of Plates, Shapes, Etc., in Total Invoice Hull Steel

Having estimated the amount of structural steel in a vessel it is of interest to know how much of it consists of plates, how much shapes, etc. This is best arrived at by settling upon the small percentage of bars, hull forgings, and rivets and dividing up the remainder between plates and shapes in the usual proportions, the shapes being angles, bulbs, channel and other sections of that nature. An assumption of 3 percent for flats, rounds and other bars, and hull forgings, and an assumption of 5 percent for rivets, will not be far out of the way. This leaves 92 percent for plates and shapes.

An examination of a considerable number of material order schedules and detailed estimates shows the following relationship of shapes to plates, when extreme cases which are manifestly out of the running are eliminated and an approximate mean value of the others is taken:

	Proportion of Shapes to Plates
Oil tankers	.50
Oil tank barges	.43
Double bottom cargo steamers	.44
Single bottom cargo steamers	.45
Steamboats	.45
Steam yachts	.47
Schooner yachts	.43
Double ended ferryboats	.50
Miscellaneous barges	.40

Using the above figure for a double-bottom freighter, we would have

	Percent
Plates $\frac{100}{144}$ of 92 percent, or	64
Shapes 64 × .44, or	28
Bars and forgings	3
Rivets	5
	100

which would mean for vessel No. 3 of Table 2.

Plates	2,135
Shapes	935
Bars and forgings	100
Rivets	170
	3,340

As before stated the figure here used is based on the assumption of 10 percent allowance for scrap. An allowance of 15 percent for scrap would run the plates up to about 2,250 tons.

As previously stated 10,302,150 deadweight tons of Shipping Board steamships were found to have 1,100,651 tons of shapes. From the above table and the relative proportion of dry cargo vessels to tankers we would expect the shapes to be about 45 percent of the plates. With the foregoing assumption of 92 percent of the total steel for plates and shapes the shapes would then be about 28½ percent of the total.

A mean value of the coefficient of column 5, Table 2, shows total steel of about 37 percent of the deadweight. On this basis the shapes would be 28½ percent of 37 percent, or 10½ percent of the deadweight. 10½ percent of 10,302,150 deadweight tons is about 1,082,000 tons, which differs less than 2 percent from the actual amount. As the above listed proportions of shapes to plates were not derived from any of the Shipping Board vessels, this rough check serves to illustrate their reliability within reasonable limits.

Weight of Steel or Iron Fastenings in a Wood Hull

Mention was made at the beginning of this paper of the importance of steel and iron in wood ship construction. The following table, showing the weight of metal fastenings in pounds per board foot of timber used up in the construction of the vessel, may be of value. The figures, cover bolts, spikes, tierods, and strapping.

2,500-ton deadweight schooner barge built before the war. Not classed but substantial construction. .33 pound per board foot.

2,500-ton deadweight schooner barge built during the war. Classed with the American Bureau of Shipping and fastenings equal to or in excess of their requirements. .42 pound per board foot.

4 types of wood steamships of from 3,500 to 4,000 tons deadweight classed with the American Bureau of Shipping. .3 to .4 pound per board foot.

Another type of steamship in which the strapping is replaced by double diagonal wood sheathing between the frames and the outside planking comes within the range above listed when some structural steel used as a sheer strake, deck stringer plate, etc., is included.

Corrosion of Steel and Iron

The corrosion of steel is much more rapid than that of iron. There are a number of iron vessels in service which were built from 40 to 50 years ago, the hulls of which are of the original material and in very good condition. There are also iron boilers of that age still in service and passed by the United States Steamboat Inspection Service, and their shells when drilled are found to be the original thickness. The building of iron vessels is, however, no longer a commercial proposition on account of the lack of rolling mills producing the material, and because of the fact that the inferiority of iron to steel in strength calls for greater weight to meet classification requirements and therefore a resultant decrease in the deadweight carrying capacity of the vessel. There are a few points, however, that it is well to pay attention to in this connection.

Iron can be obtained for fastenings, including the strapping, of wood ships; and it is much preferred to steel by at least one of the classification societies on account of its greater

resistance to corrosion. Where inside fastenings not in contact with salt water are allowed to be black, if of iron, the same items in steel are required to be efficiently galvanized. This includes the strapping between the frames and outside planking, the galvanizing of which is sometimes a difficult matter on account of the long lengths to be dealt with.

Iron rivets can be obtained and should be used with iron plates when in contact with water. When used with steel plates, however, in contact with salt water, electrolytic action sets up a rapid corrosion which renders their use under such circumstances decidedly objectionable. It is the same action that takes place in marine boilers when not well equipped with zinc plates.

The electrolytic action above mentioned is much more marked when bronze propellers are in use on steel ships, or where composition sea valve connections come through the shell in contact with the sea water. To prevent the rapid corrosion of the steel in such cases, zinc plates should be ordered for application to the stern frame or plating in the region of the composition casting. The electric current will then pass through the water from the zinc to the bronze instead of from the steel to the bronze.

A marked corrosion may be expected wherever the fibres of the material have been severely stressed. This has been referred to previously in connection with the use of joggled shell plates.

Another point to be borne in mind is to not have steel studs and nuts for tank manholes, stuffing box glands and other similar service where subject to corrosion. The stud can be of composition and the nut of steel, or vice versa; but in the latter case the nuts will be much more subject to mysterious disappearance.

Cast Steel

This material has come into extensive use for stern frames, rudders, anchors and chain cables, deck fittings, crank webs, crosshead slippers, bearing boxes, short pieces of curved piping, and a great variety of work about a vessel. With this material, even when made under good specifications, and the castings properly handled and annealed, shrinkage cracks are apt to develop in large castings; but the troubles from this source have been greatly reduced by the growth in successful application and classification favor of the several kinds of welding.

With cast steel frames, cracks which ultimately result in fractures are most apt to develop at the junction of the propoller post and shoe; and with single screw steamers it is a wise precaution to have scarfs that will admit of the renewal of the lower part of the frame without removal of the propeller shaft boss and the upper part around the overhang.

Semi-Steel

This material is used for propellers, gear wheels, base castings and other work about a vessel. A quite usual formula is:

	Percent
Pig iron	50
Cast iron scrap	25
Steel scrap	25
	100

which should produce a material having a tensile strength of about 30,000 pounds per square inch. Some manufacturers use as much as 40 percent of steel and turn out a material that has a tensile strength of from 35,000 to 40,000 pounds per square inch.

Semi-steel is not a suitable material for rail stanchions and other items of small cross sectional area in proportion to their length, as it has not the requisite ductility.

Malleable Cast Iron

This material is a kind of crude wrought iron produced from cast iron by subjecting the castings to a process which removes a large part of the carbon. The process takes several days, even for castings of small size; the shrinkage is considerable; sharp angles have to be avoided; and there should be as much exposed surface as possible. It is of value for rail stanchions, hatch cleats, portable hatch stanchions and sockets, clinch rings and small castings generally, where cast iron would be too brittle or too cumbersome; although its field is limited by the availability of cast steel.

Cast Iron

The chief point to look out for when ordering cast iron is to secure castings that will be easily machined and free from blow holes. This is not altogether either a matter of the formula or of allowing the casting to cool properly. Some manufacturers have the knack of and reputation for turning out castings that other manufacturers do not appear to be able to produce. So a knowledge of the product of the maker of iron castings is of value. This is particularly the case for cylinder castings, propellers and other items where the quality of the material is highly important.

A peculiarity of cast iron is that it grows with repeated heating and cooling. Castings which form bearings for pins, shafts, etc., when loose in the bore can be sometimes *shrunk*, or reduced sufficiently in diameter of bore to be serviceable, by a single heating to a white heat.

There are a number of special mixtures or alloys of steel made by the addition of one or more of the metals—nickel, chromium, manganese, or vanadium, and also special mixtures and products of iron; but they all have their definite chemical compositions, properties and uses and call for no particular mention here.

Flying Deck of H. M. S. Eagle

View of the Stern of the Vessel

As shown by the above photograph of the flying deck of H. M. S. *Eagle*, the funnel of the vessel is at one side, so as to give space for the aeroplanes alighting or leaving. The part of the flying deck over the stern of the ship is sloped to give impetus to machines leaving, and to act as a brake to machines landing.

Fairing Ships During Construction

Hull Construction Methods Used at the Harriman Yard of the Merchant Shipbuilding Corporation

BY W. M. KENNEDY*

CONSIDERABLE trouble was experienced with fairing and regulating the earlier ships constructed at the Harriman yard of the Merchant Shipbuilding Corporation, which resulted in an unusual number of plates being lost through bad rivet holes.

In the beginning this bad work was laid to poor regulating, and in an attempt to raise the standard of this department the best available men were assigned to assist. No improvement, however, resulted, and a check was next made at different points throughout the ship and the true cause of the trouble found. It proved to be fairing. Exceptional care was then given to fairing work by shipwrights in the old way in an attempt to overcome the abnormal loss of material, but the desired effect was not forthcoming.

At this time it was suggested that a transit be employed for checking up. As usual, such innovations were not taken very kindly to by those in charge of a particular line of work, but in a very short time the advantages of this method became apparent and all concerned were giving their best efforts to devise additional checking points. The effect of this careful checking by the use of a transit resulted in better work and less material loss through condemnation.

Checks Performed During Construction

The final procedure adopted to insure the fairness of a ship during construction follows:

(I) Preassembly

1. (a) Supports for keel undergoing preassembly are lined and graded.

(b) Supports are checked before a new keel is laid down in preassembly from control stakes under each horse of the berth.

2. The bolted keel is checked in its entirety before being riveted.

3. Stern frame is checked before being chipped.

4. Stern frame is checked after frames and plates are bolted on.

(II) On Ways

1. Keel blocks are set before laying of keel.
2. Keel is checked from control points underneath.
3. Floors are checked for height at outboard end in relation to base line.
4. Bulkheads are checked for line and grade after being bolted in place by side shell plating.
5. Stern frame is checked after being bolted.
6. Launching ways are set.
7. Hog or sag of vessel after being launched is determined.
8. General remarks.

Methods Used for Checking

The methods used for carrying out the above checking procedure are as follows:

(I) Preassembly

1. (a) Supports for keel undergoing preassembly are lined and graded.

The supports which occur at approximately 10-foot intervals are originally brought to a true centerline and a true grade line, each bent being leveled up as well.

(b) Supports are checked, before a new keel is laid down in preassembly, by control stakes.

These control stakes are driven flush with surface of ground at each support.

The line is set directly on each stake and the grade is referenced by a tack in the side of each stake so that the keel can be checked even though the supports are moved.

2. The bolted keel is checked in its entirety before being riveted.

By plumbing up from line in control stakes and measuring from the grade nails in control stakes, the keel is faired to prevent the difficulty of bringing the assembled sections to the line and grade when placed on the keel blocks.

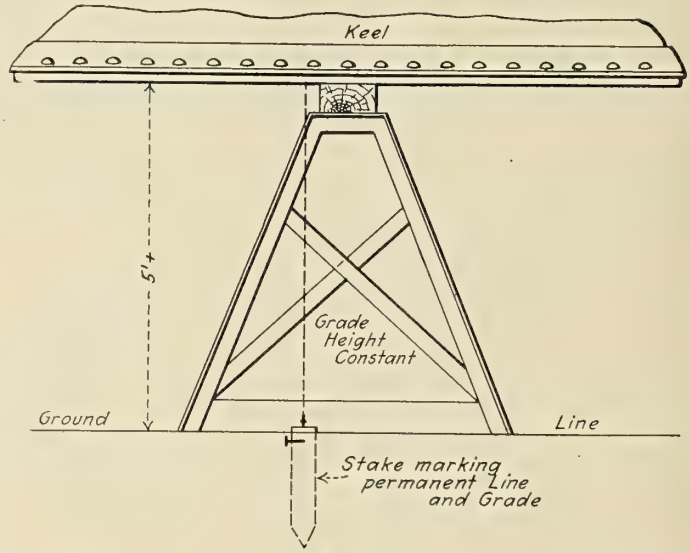


Fig. 1

3. Stern frame is checked before being chipped.

(a) After the rough castings are laid down in the preassembly space, the stern frame template is applied and a line which most nearly parallels the rudder post and the upper and lower palms is marked on the sides of the castings, usually the line of No. 1 frame.

The 6-foot waterline is transferred from the template to the casting at this time, due consideration being given to (1) fitting to the shoe of the frame to reduce chipping to a minimum; (2) fitting to the center of the boss to facilitate drilling and keep enough metal on all sides; (3) landing on the palms.

The reason for marking the 6-foot waterline is to establish a pitching spot or bench mark from which to fix the vertical position of the stern frame later. A tolerance of an inch or so above or below the designed line of shafting is often allowed, and this tolerance permits the stern frame template to be juggled a little with a view to reducing the chipping to a minimum, etc., as noted above.

(b) A base line, squared with the line paralleling the rudder post, is then established at the lower end of the casting and the 6-foot waterline is then corrected to parallel this base line, the corrected position being marked for future use when placing the stern frame in position on the ways.

It sometimes happens that after the base line is established the shoe of the stern frame is found to be warped in a vertical

* Assistant works manager during construction.

direction and out of square with the rudder post. When such is the case correction by heating is necessary.

The scarph line for the offset to take the keel is then located from the base line and the casting chipped as required.

Caution might be added here against working on a casting when it is out of a horizontal plane, remembering that if the forward end of the shoe is out of the plane and the top of the palm also, the plane of the stern frame will not be square even though the post is square to the base.

Fig. 2

(c) A test should always be made to determine whether the centers (considered athwartship) of the boss, the palms, the foreward and after ends of the shoe are in a plane.

These points must be brought to a plane (by heating the casting, if necessary), else when the stern frame is erected they will not coincide with a vertical plane through the center of the hull.

This work should be done by the carpenters principally, as it makes for simplicity of operation in the field.

One method of doing this is to clamp 4-inch by 4-inch wooden posts at the several above-mentioned points, the 4-inch by 4-inch uprights being nearly vertical when the frame is horizontal.

Points at an equal distance above center (athwartship) are then taken on the uprights and these points connected with a line drawn taut. By sighting over the lines a quick survey can be had and any necessary corrections made.

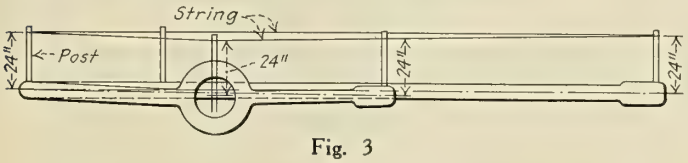


Fig. 3

(d) If heating is necessary either for squaring (operation 3b) or for bringing to a plane (operation 3c), the casting is again checked for both operations.

4. Stern frames are checked after frames and plates are bolted on.

(Note) The practice is to rivet the shoe plate, boss plates and other strakes which are riveted to the stern frame while the frame is in preassembly.

The shoe plate is checked for squareness (operation 3b) by a transit before riveting, also for plane (operation 3c). This is accomplished as follows:

The shoe plate, or aftermost keel plate, is bolted to the stern frame and stern framing forward to and including the afterpeak bulkhead, which is then bolted in position. After the frames are set in place the shell plates (other than the boss) are bolted to the frames and clamped to the stern frame. The assembly is then checked by measurements to heel of frame and by a transit to insure that the shoe plate is square to the rudder post and also that the centerline of the palms, boss and bulkhead lay in the center plane of the vessel. The plane of the transit is brought to coincide with the stern frame and the structural assembly adjusted until the centerline of the bulkhead falls in this plane, the clamped connection to the stern frame forming a slip joint makes this adjustment possible. The boss plate is then set in place and the entire assembly riveted.

(II) On Ways

1. Keel blocks are set before laying of keel.

Three battens are set from control nails in the stringers—one near the bow, one amidships, one near the stern. The transit is set over the one at the bow or stern, tide and direction of light determining which one is used.

A sight is taken on the batten at the other end, checking on the midship batten and the rake and the grade established. Other battens are then set at 20-foot intervals (a total of 20 battens for a 400-foot vessel) each being adjusted to the bottom of the flat keel, leveled up athwartship with a spirit level and marked with centerline.

(Note) As soon as two battens are set, the carpenters erect the keel blocks and stretch lines, marking the amount to be dressed off the top keel block, which is then taken to a band saw to be cut. It is then replaced while other carpenters mark the centerline with a saw cut. This centerline is brought to a line stretched over the battens and the block secured in place.

This releases skilled mechanics from adzing, which is slow, and concentrates them on laying off the blocks and centering same, which operation follows closely on the setting of each successive batten.

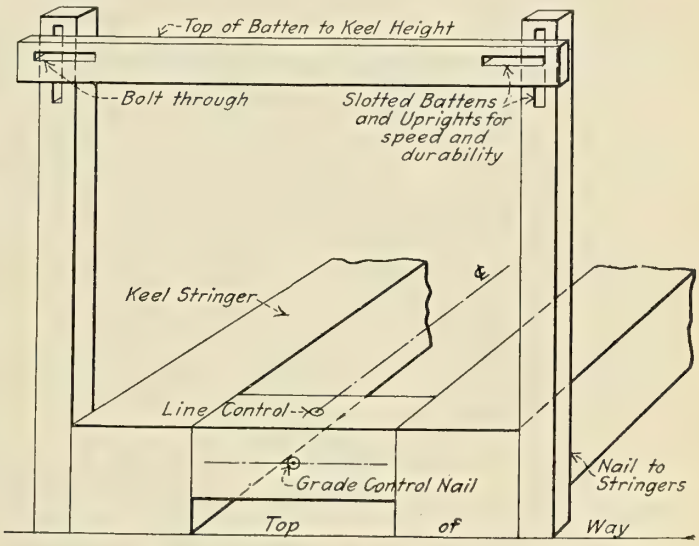


Fig. 4

2. Keel is checked from control points underneath.

After the keel is laid and shored in place by carpenters it is checked by an engineer from the control points underneath.

This is of particular advantage in offering a ready way of holding the hull to line and grade as the work progresses, as well as for projecting the line and grade for boring out the boss and giving grade from which to locate the draft markings.

3. Floors are checked for height at outboard end in relation to base line.

Floors are tested for squareness with centerline at sufficient intervals to control their spacing at the outboard end.

The floors, having been regulated to the vertical keelson, are next leveled to bring the outboard end in correct relation to the base line of the hull.

The keel having been already checked and regulated, battens are run out to the side of the ship in way of the floors selected and leveled with a spirit level to the under side of the keel. Dimensions furnished by the mold loft give the deadrise of the floor in question, permitting the outboard end to be set in proper position. The intermediate floors are then placed in position and adjusted with a transit by establishing a plane above the outboard ends of the floors leveled as above.

4. Bulkheads are checked for line and grade after being bolted in place by side shell plating.

The bulkheads are controlled by shores and wire stays, as well as some bolts through side shell plating.

By placing the transit on the centerline on the tank top and picking up the centerline, it can be checked at the second and upper decks and even to the bridge without the necessity of

being held up by the oscillations of a plumb bob, as is the case when this method is used.

In plumbing on the after side of a hatch it is possible to hang a plumb only from the upper deck to the second deck in one operation, due to the declivity. A separate operation is necessary to plumb from the second deck to the tank top. The transit does this more expeditiously and more accurately and it is the only possible way to plumb the entire distance in one operation.

Results on bulkhead plumbing for line are checked by leveling on the "waterlines," which are located on the face of the bulkhead.

5. Stern post is checked after being bolted.

The stern post is checked for line and grade by placing the transit on the centerline aft of the stern of the ship about 30 feet. Lines and grades are picked up from control nails and the stern assembly is then brought to accurate line and grade without the necessity of plumbing, which operation is difficult for such a length when the weather is at all windy.

6. Launching ways are set.

Battens are set at approximately 40-foot intervals from the inboard end of the ground ways, extending to the inboard end of the seaways. These battens are set from the same system of control nails which governed the keel block battens.

Particular care should be exercised to check the seaways as each set of launching battens is set. This is a safgeuard against any tendency to irregularity or failure of seaways. The entire length of seaways is tested immediately after each launching to determine any tendency to failure. An imperfect joint, such as a summit in the grade, at the junction of the ground ways and seaways, or any sinking of seaways, is thus predetermined and corrected by carpenters, if dangerous.

7. Hog or sag of vessel after being launched is determined.

On the day before a launching the transit is set up on the upper deck just aft of the forecastle deck house. A line parallel to the deck is projected to the forward face of the after deck house and chiseled in. When this line is established rods are read at every fifth frame. This produces the profile of the deck, which profile is used as a comparison with the profile obtained in a similar manner after the vessel is launched.

In addition to the deck profile, a profile of the shaft alley is taken and compared.

8. General remarks.

It should be borne in mind that the prime necessity of this method is to facilitate construction by greater accuracy of fit among the several parts of the hull and the determining factor in calling for accuracy of regulating of these parts is not how closely they can be surveyed and brought to line and grade, but at what point accuracy in regulating costs more to obtain than it returns in saving in the other lines of work, equality of finished product being maintained as the first requisite and speed of construction being borne in mind.

Endeavor so to plan the checking of any hull that mistakes are anticipated and not exhumed.

Work in close conjunction with the shipwrights; their views are often most comprehensive of the entire crankiness or fit of the hull in question, and in them lies the control and corrections.

Relation of Portable Tools to Building Berth

Number of Tools Required for Building Ways and Wet Basin—Location of the Tool Rooms and Care of Tools

BY MAURICE NICHOLLS

DURING the years of 1917 and 1918, when shipyards were springing up over night, the first problem that presented itself to the management, after the site had been selected, was the question of the number of tools. Due to the fact that no data had been made public along these lines, tools were bought largely on guess or by a limited comparison with other yards then in operation. As a direct result of this, many yards overstocked themselves, while others went to the other extreme.

The problem which now confronts the yards that have survived the war building programme is, how many tools do we really need? At first thought it would appear that this question cannot be approached with any degree of precision due to the fact that each governing factor is a variable, the factors being "*A*" size of ship, "*B*" number of ships under construction at one time, and "*C*" the type of ship. It is evident that each of the above has a limit. Factor *A* is limited by the size of the building way and *B* by the number of ways in the yard. The type of ship requiring the maximum number of portable tools is the tanker type. This is evident because of the additional bulkheads and the extra watertight work. These cases form the upper limits of the variables. At the same time, consideration must be given to the fact that there probably never again will be a time when each yard, the country over, will have a ship for each building berth. Prior to 1916 a yard with five building ways was large, and it was nothing short of phenomenal if all of the ways were occupied at the same time.

From the standpoint of the work on the Great Lakes, the limit of factor *A* may be safely put at 650 feet. During the war the Lake yards were busy with vessels 261 feet in length, which is the maximum length unit that can be brought down to tide water. The 650-foot vessel is, in all probability, the upper limit of the modern Lake freighter, although there is in operation today one vessel 635 feet in length.

Turning from the Lakes to the coasts we find that vessels were projected varying from tugs 150 feet in length to the new battle cruisers which measure well over 800 feet. However, 800 feet in length is what might well be termed unique in the annals of shipbuilding in this country, and it was only after alterations were made that one or two private and government yards could undertake to build this size of vessel.

From a review of the contracts pending for 1921 it will be safe to estimate that 98 percent of the vessels to be built will not be over 500 feet in length.

Tool Room

One of the most important items in the consideration of portable tools is the location of the tool room. Many yards have located their tool rooms so that they are readily accessible from one building berth while they are at a decided disadvantage from the remainder. Based upon actual studies made by the writer in several yards on the Great Lakes and east coast, the time consumed for a round trip from the building berth to the tool room ranged from fifteen minutes to one hour and seven minutes. These were not made on any special hurry trips, but the ordinary trips a workman makes during the day—no doubt each trip accompanied by the usual side

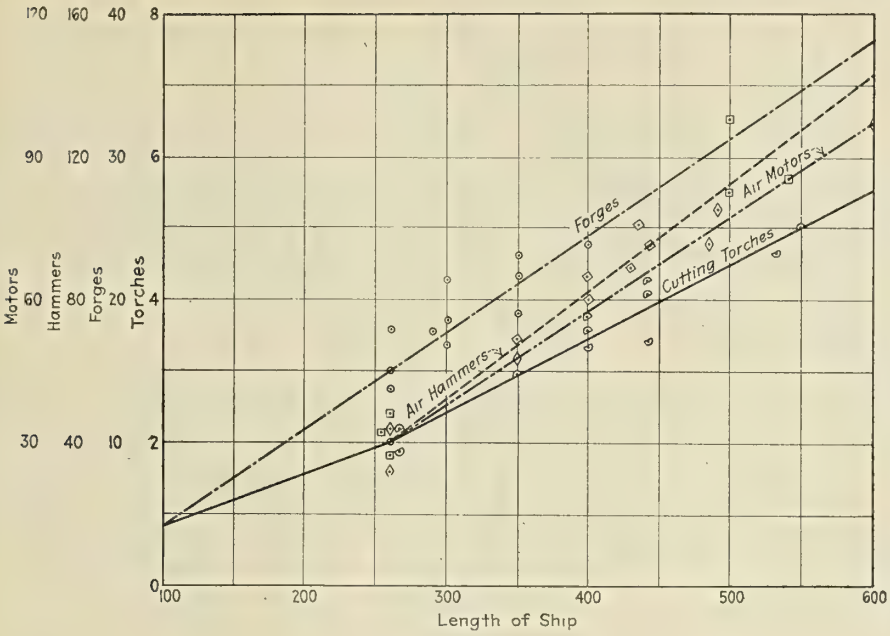


Fig. 1

trip to the toilet or drinking fountain. Even the minimum round trip time multiplied by the number of trips per day from a ship gives a result almost unbelievable. This is lost time.

Sub-Tool Room at Head of Ways

A sub-tool room maintained at the head of each or each pair of building berths will be a great aid in reducing this loss. These sub-tool rooms may be designed to be portable, sling attachments being provided to permit handling with a traveling crane, the idea being to only issue tools and to keep on hand only those tools that are in first class shape, the tool maintenance being taken care of in the central tool room.

It will not be necessary to keep at all times the entire number of tools allotted to the ways in question. The number of tools required per week can be obtained from the foremen of the various crafts in advance. For example, the bolter foreman notifies the sub-tool man that by the end of the week sixty gangs of bolters will be on the ship, and the sub-tool man arranges his stock so that if a tool is broken or out of commission it will only be necessary to go to the sub-tool rack and have the exchange made.

Portable Tool Requirements per Way

In order to visualize the tool requirements per building way, the writer has prepared several curves. These curves comprise the important portable items used on each way and are plotted to the length of ship. As no information has been gathered on vessels exceeding 600 feet in length, the curves are not extended beyond this length. These curves have not been drawn to any special type of vessel, but form the mean between the types requiring the maximum and minimum portable tools, i. e., tankers and general freighters. It has been demonstrated on the east coast, however, that tankers have been built size for size with freighters with only 5 percent additional tool requirement per way.

Considering the curves in Fig. 1, the term forges is applied to the ordinary pea coal rivet forge and the term hammers to riveting and holding-on hammers. Hence, the first point 40 means 20 riveting guns and 20 holding-on guns. The calking guns are read from the same curve, but also include the tools used by the test gang. Thus point 40 on the 250-foot vessel denotes that 40 calking hammers will be required, divided among the day workers, piece workers and the test gang. The curve for gas cutting torches is self-explanatory.

No curves are plotted for riveting dies, reaming or countersinking tools. These stand in the ratio of 5 to 1 with the machine they are used with. For example, on a 350-foot vessel the maximum number of riveting hammers multiplied by 5 gives the number of riveting dies per way. The ratio of chipping and calking tools is figured in a similar manner using the ratio of 8 to 1. Welding torches are in the ratio of 1 to 2 with the cutting torches; however, the same cutting operator can handle this work if care is used in the selection of men. One electric arc welding machine should be provided for vessels up to 275 feet in length and two per way for vessels up to 500 feet. Oil heating torches should be provided two per way.

Fig. 2 shows plotted curves for wrenches, goggles and lineal feet of air hose. While these curves are plotted from actual shipyard figures, good results may be obtained by the following method. The maximum number of bolters used on a certain type of ship can be readily determined and this number multiplied by four will give the total wrench requirements. Regarding the number of goggles per way, each welder, burner, grinder, chipper and calker and three out of every five riveters must be supplied, the surplus noted on the curves being used to handle the miscellaneous cases.

The maximum lineal feet of air hose per size of ship varies for each yard due to the fact that each yard differs somewhat in the method of supplying air at the building berth. This curve has been drawn as a mean and does not include hose for work at the assembly ground.

Surplus Tools

After the consideration of the number of tools required per way the question of surplus tools at once presents itself. The proper surplus to allow varies greatly dependent on the care exercised by the men using the tools.

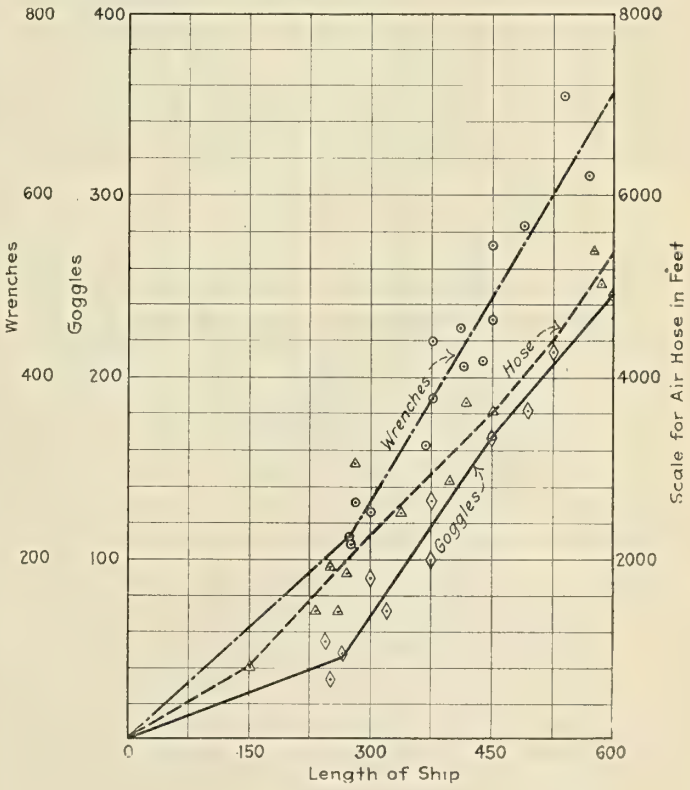


Fig. 2

To much emphasis cannot be placed upon the proper maintenance of the portable tools. The actual treatment of the tools, however, varies greatly according to the district and the class of men employed.

Care of Portable Tools

In regard to the treatment of tools, a craftsman becomes attached to a tool by use, and, recognizing this fact, the best results can be obtained by re-issuing the same tool to the same individual as far as possible.

Several yards, in order to bring out this point, offer a tool prize which is awarded monthly to the man who keeps his tools in the best shape. This scheme stimulates an interest in the care and upkeep of tools, relieves a big burden from the tool repair room and has accomplished good results in connection with welding, burning and electric welding machines and also small tools such as wrenches, dies, etc. The principal criticism against this plan is that it takes men from their work, the men working on their tools when they should be working with them. A piece worker is after the money, and it is to his advantage to have his tools in such shape that he can produce the most work during the working period. Any person who has been a foreman or superintendent will admit that there is a lot of commotion if the tools are not in proper shape. On the other hand, there is the question of the employee on day work. It is this class of workmen who are the most destructive. Out of a hundred consecutive "breakdown" cases presented at a window of a tool room, eighty-four were at the hands of day workers. Another random case based on the breakdowns submitted from one building way showed that seven out of ten were from day workers. The success or failure of this tool maintenance prize rests, to a large extent, with the sub-foremen and gang leaders.

Another way of preventing lost time and at the same time adding to the life of tools is to have a tool repair man assigned to one or two berths. This man carries a portable tool repair kit, oil and grease and makes the rounds of the men on the ship, attending to minor repairs, oiling tools and approving the necessary trips to the tool room. This scheme eliminates trips to the tool room for minor repairs and has proven very successful due to the fact that workmen, especially day workers, take advantage of the slightest defect to take a walk to the tool room.

By providing a portable tool grinder at the sub-tool room when work is started on a berth, considerable time is also saved. As construction proceeds one or two of these tool grinders should be placed on the ship itself.

Tools for the Wet Basin

In all of the above discussion consideration has been given only to the building ways. The question of the wet basin or finishing pier presents considerable more difficulty due to the fact that vessels are launched in all degrees of completion. Several cases are on record where vessels were launched riveted only up to the light load line, and, taking the other extreme, vessels have been launched complete even to steam. In view of this there is a great range of tool requirements. The percentage of completion for launching varies according to the demand for room for new work, contract requirements and miscellaneous requirements.

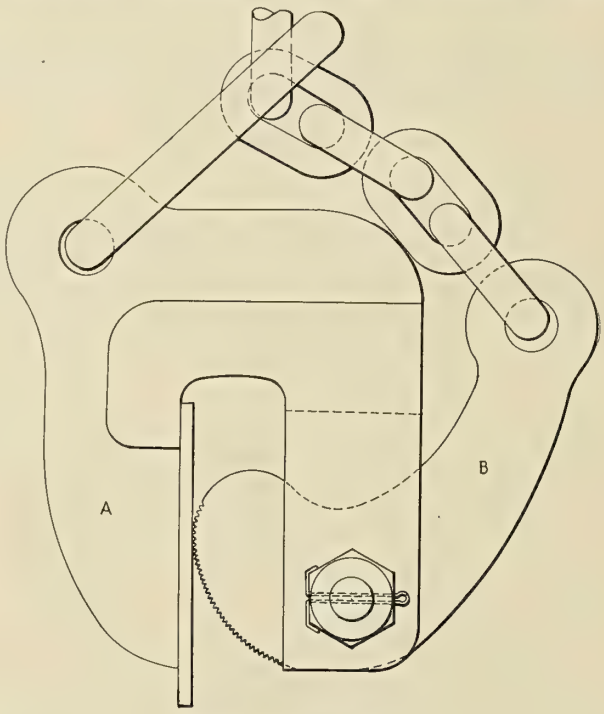
It is not necessary to establish a separate account of tools for the wet basin or maintain a running surplus for portable hull department equipment if the tools are proportioned to the building berths. The tools necessary to complete the vessel should be carried over from the building berth. It is evident that before the maximum number of men can be employed on the keel which is to be laid the work involving the use of the same tools will be completed on the ship just launched. This is true only in normal times and cannot be used where a large contract of sister ships is to be turned out under war pressure, as one glance at the fitting-out basins of the yards during war times would show.

It must be borne in mind, however, that the largest tool losses and greatest percentage of breakage occur at this stage. This is due in a large measure to the fact that small tools are thrown to one side and soon covered with débris incidental to the work at this point in the construction. Two percent of the larger portable tools should be added to the total tools per building way to cover this loss, and from 5 to 8 percent on smaller tools such as wrenches, dies, dollies, etc.

The Comrie Safety Hook

An ingenious safety hook for the efficient and safe handling of plates has been designed and invented by Alexander Comrie of the Standard Shipbuilding Corporation, Shooters Island, N. Y., for handling material in that yard. The hook grips plates through friction the moment the pull is exerted by the overhead crane and has been found to increase the handling efficiency. This device is now in use in other shipyards in the New York district.

Referring to the illustration, the hook consists of the jaw *A*, which takes the plate or plates, and the tongue *B*, to which



Sketch of Safety Hook

is attached the chain leading to the crane and swings up when the pull is exerted, gripping the plates fast. The hook will lock itself on the load irrespective of the direction in which the pull is exerted and two or more plates can be handled at one time with equal facility.

A load of sufficient weight to bed the teeth of the tongue piece into the surface of the plate, for instance, a load of from one-half ton up, could not possibly become disengaged by slacking of the tension on the lifting chain. The gripping strain is about four times the load weight and the locking strength so great that the tongue usually requires to be tapped loose after landing the plates in the position desired.

Last Shipping Board Keel Laid.—Of the 2,312 ships built or building for the Shipping Board, there remain 50 vessels of 407,412 gross tons under construction still to be delivered, the keel for the last of these being laid March 17 at the plant of the Northwest Steel Company, Portland, Ore.

The Modern Cargo Vessel*

BY WILLIAM GATEWOOD †

Civilization is made possible by commerce, and as commerce cannot thrive without suitable means of carriage, the humble cargo vessel is the handmaiden of progress. The cargo vessel, like so many other institutions, has been an evolution and the type of vessel has adapted itself to the needs of the day and generation. How the modern cargo vessel has been evolved to meet the present day needs of commerce is shown in this paper.

THE modern cargo vessel is built of mild steel, is propelled by a screw propeller operated generally by steam machinery, is steered with a rudder operated by steam and controlled from the bridge, is navigated by magnetic compass, has its location determined by chronometer and sextant, and has its cargo handled by block and tackle from booms on masts or derrick posts by means of steam winches. The size, arrangement, speed and fuel are specialized to suit the exact requirements of the trade, and few trades call for exactly the same design.

Cargo Vessel of the Future

The cargo vessel of the future may be built of high tensile or special steel but there are no indications at present that mild steel will be superseded in the near future, except on the largest vessels. It may have some other kind of propulsion than by a screw propeller, but there are no indications of any more efficient method, although some improvements may be made in the type of screw. The reciprocating steam engine is being superseded by the geared turbine, and the turbine is being used also in conjunction with electric generators and motors, instead of gears. The watertube boiler for generating steam is now becoming almost as well known as the cylindrical boiler, and the majority of new vessels use oil as fuel instead of coal. The internal combustion Diesel engine is being developed and used, and it is possible that this will be the prime mover of the future on account of its economy, unless oil becomes too expensive to be used at all. Electric motors are well suited for operating any type of steering gear, including hydraulic, and when steam is not used for propulsion, electric auxiliaries are the natural arrangement. The gyro-compass may replace the magnetic compass, as the gyro-compass is now used on Atlantic liners and in the Navy. The variation of the magnetic compass, first discovered by Columbus, is still a source of confusion, and the deviation of the compass due to the ship's magnetism is a continual cause of anxiety to the navigators. No substitutes for the chronometer and sextant are being experimented with, so far as I know, but the "wireless" is already being used to give the location near the coast in a fog, and to check the time. Electric winches are common on naval vessels and are used also when internal combustion engines constitute the propelling mechanism.

> We are interested in the modern cargo vessel as an efficient instrument for the carrying of the world's commerce and for the advancement of civilization, and also from a national viewpoint as a means of maintaining and protecting the independence of the United States. For this latter purpose, no minor sacrifice should be allowed to overshadow the great gain in independence which will result from our ownership and operation of a large fleet of modern cargo vessels.

Concrete Ships Generally Impracticable

Reinforced concrete is being used in the construction of cargo vessels to a limited extent. The aggregate used weighs much less than that used in land construction, so that the concrete vessel is not so very much heavier than the steel vessel. Concrete, however, is liable to develop cracks under tensile stress, and the sides seem to be susceptible to damage in docking. It does not seem likely to be much used for ship construction in the future. In a well designed steel vessel of large size, almost all of the steel is required to withstand tensile stress, and so no reduction in the amount of steel used for reinforcement could be made, as the concrete is of value only in compression. The weight of the concrete must be almost entirely in excess, therefore; and the reduction in cost of construction, if any, can hardly be great enough to offset the loss in deadweight.

The size of a cargo vessel is made to suit the length of voyage and the amount of cargo available. There is no economy in having a large vessel in a given trade unless the vessel can be fully loaded on most of her trips. The commercial life of a vessel may be taken as 20 years, and a depreciation of at least 5 percent per annum on the investment should be allowed as a part of the cost of operation. Not less than 5 percent interest on the investment should be gained in addition, and repairs will amount to an average of not less than, say, two percent of the first cost, so that not less than 12 percent of the first cost must be carried each year in addition to the cost of operation. The first cost, therefore, is of prime importance in determining the particulars of a vessel. Other things being equal, the cost increases with the size, and therefore the vessel should not be larger than the amount of cargo justifies.

Economical Size of a Cargo Vessel

The economy in operation resulting from increase in size, however, is very great. It takes very few more in the crew to man a vessel of 10,000 tons than to man a vessel of 5,000 tons, as the same number of licensed officers are required on each vessel and only about six additional men are needed in the crew. The horsepower required for the same speed is increased in the larger vessel by only about 50 percent, and the machinery may be made somewhat more economical so that the fuel consumption will be increased by less than 50 percent. If the operating costs of crew, fuel and supplies amount in the course of a year to 30 percent of the first cost in the case of the smaller vessel, they would amount to only about 24 percent in the case of the larger vessel.

The larger vessel would carry about 2¼ times as much cargo in the course of a year, as the machinery and fuel would occupy proportionately less space and weigh proportionately less, and the number of voyages need not be less, as the slight increase in the time in port, if any at all, would be counterbalanced by the less interference with regularity of speed on account of bad weather.

The first cost of the larger vessel would be considerably less than double that of the smaller vessel, on account of the fact that the weight and cost of the hull and fittings is not

* From a paper presented before the Mechanical and Engineering Section of the Franklin Institute, Philadelphia, Pa., January 13, 1921.

† Works manager, Newport News Shipbuilding and Dry Dock Company, Newport News, Va.

twice as great and the cost of the machinery would be only about one and a half times as much. The first cost may be taken as about 1.8 times as great.

The advantage of doubling the size of a vessel, then, may be summarized as follows:

The carrying capacity of the larger vessel will be about 2¼ times as great.

The operating cost of the larger vessel will be about 36 percent of its first cost when the operating cost of the smaller vessel is 42 percent of its first cost.

The first cost of the larger vessel will be about 1.8 times the first cost of the smaller vessel.

The comparative cost of operation of the larger vessel per ton of cargo will be only about three-quarters as much as the similar cost for the smaller vessel.

Effect of Increased Speed

The natural thought would be that by increasing the speed of a vessel quite an advantage would be gained. Such is seldom the case, however. If a vessel, for instance, has a speed of 9 knots and spends two weeks at sea to one in port, the first cost of a vessel to carry the same weight of cargo each trip would be nearly double for an increase in speed of 50 percent, and the cost of operation would be at least double, while the faster vessel would carry only 30 percent more cargo in the course of a year. It is this economic fact which keeps the average speed of cargo vessels so nearly the same as it was twenty years ago. The tendency in this country, however, is to build for a speed of between 10 and 12 knots, and few vessels are being built of less speed than 10 knots. The effect of bad weather is much greater on the slower vessels, and the increased length of time the cargo is in transit operates to reduce the freight rates. It is generally conceded that only vessels for carrying passengers and express freight should be designed for speeds in excess of 16 knots, and quite a number of passenger vessels are running at a speed of about 14 knots. The larger the vessels the less the economic disadvantage in the higher speed, as the power required for the same speed does not increase directly as the size of the vessel but only as about the two-thirds power of the displacement, and a somewhat higher speed can be obtained without using as great a proportion of the displacement for machinery and fuel.

> The great problem before this country at present is not a lack of vessels, but a lack of experienced operators to manage the vessels. Any marine policy which overlooks this fact is doomed to failure. The difficulty of the task, however, should not deter us from tackling it in earnest, and the nation which bore the honors in shipping a century ago is doubtless able to repeat its performance at the present time.

The Block Coefficient

The underwater form of a vessel may be made quite bluff, if a low speed is deemed sufficient, but the lines must be made finer as a higher speed is sought. The block coefficient is the term used to denote the proportion which the volume of the vessel under water bears to the circumscribed parallelopiped. For a speed of 10 knots the block coefficient is about 80 percent in a vessel 400 feet long, and may be increased to 82 percent in longer vessels, while it would be reduced to 78 percent in a vessel 350 feet long. It ranges between 78 and 82 percent in the ordinary cargo vessels. As the speed increases, the block coefficient is reduced, and in some recent freight and passenger vessels 518 feet long and designed for a speed of 16 to 17 knots it was made as small as 65 percent.

The high cost of construction of the hull, and the broken stowage, however, do not recommend such a fine block even though a higher speed is obtained for the same power. Bad weather reduces appreciably the speed of a very fine vessel, causing heavy pitching, so that a vessel should be neither too bluff nor too fine. The present tendency on cargo vessels is toward a fining of the bluff bows which were so common earlier in the century, and also toward fining the stern, not only to preserve the trim, but also to give a better flow of water to the propeller and to gain in efficiency of propulsion thereby.

Sheer

The above water form of hull of modern cargo vessels provides usually a flaring bow in order to prevent the waves from breaking over the deck, a smooth sheer line with about twice the rise forward as aft, with erections to suit the needs of the service. In most of the fabricated vessels, there is no sheer at all, but such vessels are not as good sea boats, and under the present rules for determining freeboard they cannot load as deeply. Many vessels have been built in this country with a straight sheer for the half length or more amidships and with a quick sheer forward and the usual amount of sheer aft. This practice simplifies the construction, increases the strength somewhat, and does not offend the average eye. It will probably come into more general use, especially when the rules for determining freeboard are made rational instead of empirical.

Vessels with forecastle, bridge and poop are still the most common, although the shelter deck type is coming more into favor. The latter provides more cubic space for the same weight of cargo, and is better adapted for general cargo on that account.

The submarine is not likely to be a competitor with surface vessels in the carrying of cargo, as all the troubles of surface vessels are magnified greatly when the complications of running submerged are added to the navigation on the surface.

If a vessel is not always sure of a return cargo, and has no means provided for a large amount of water ballast, the machinery is usually placed amidships. This is the common type. In oil tankers, colliers, and a few liners, including some vessels carrying passengers, the machinery is located aft, and this type of vessel is becoming quite numerous. The midship portion of the vessel is the best for carrying cargo, while the machinery fits very nicely in the stern, and the troublesome shaft alleys are avoided.

Location and Types of Machinery

The type of steam engine installed on most cargo vessels is the inverted vertical three cylinder triple expansion reciprocating engine. This type has been in use for about forty years, the first successful one having been installed in 1881 in the *Aberdeen*. It has been improved in details, and the ratio of expansion has been increased as the boiler pressure was raised, but it is essentially the same machine and engineers have become so accustomed to it that a breakdown in service is almost unknown. A number of four cylinder triples are in service, and the four cylinder quadruple engine is quite common in liners, and very economical.

The geared turbine was introduced in cargo vessels in 1910 by Sir Charles Parsons on the *Vespasian*, as the only method of using steam turbines on slow speed vessels with any economy. The modern gears are not of the same type as were used sixty years ago in the *Great Eastern*, for instance, but are of steel cut with the minutest accuracy. A high speed of revolution is necessary in order that a steam turbine shall function with economy in the use of steam, while a slow speed of revolution is necessary in order that the propeller shall be efficient. A gear ratio of 15 to 1 is about the average for a single reduction, while a ratio of between 30 and 40 to 1 is used with double reduction gears. Both the Curtis and Parsons type of turbines are in common use, but neither

has displaced the reciprocating engine as yet. So many are now in use that the reliability of both the turbines and gears will be determined shortly, and as they weigh less, take less room and have possibilities of economy greater than the reciprocating engine, they seem sure of an extended use in the future.

Electric propulsion was introduced on the naval collier *Jupiter* in 1913 by the General Electric Company and has recently been fitted on merchant vessels. In this system of propulsion, an electric generator is driven by a high speed turbine, and the propeller is operated at a suitable speed by a motor. The steam consumption is very moderate, and some eminent marine engineers in this country consider that the electric drive is one of the coming forms of propulsion for cargo and passenger vessels. It is slightly heavier than the reciprocating engine and much heavier than the geared drive, and probably will prove more expensive to build, so that its future use will depend on how well it can overcome these handicaps in the course of its development.

The internal combustion oil engine for marine use was introduced in Italy in 1910. It has been developed up to units of slightly over 2,000 horsepower, and its consumption of fuel oil is reported to be only half as much as in the best form of steam machinery. In its present state of development, it is considerably heavier than steam machinery of the same power. The earlier installations have not always proved reliable, but as experience has been gained in its design, construction and operation, it has given greater satisfaction in service. At present, its first cost is considerably in excess of steam machinery, and the power of a single unit is limited, so that it offers no immediate advantage financially except on long voyages on which the saving in the fuel supply needed will enable a heavier cargo to be carried. A recent American installation is that on the *Cubore*, which came out in the summer of 1920.

Boilers

The use of steam machinery for marine purposes was handicapped until the cylindrical multitubular boiler, commonly called the Scotch boiler, was developed in about 1862. As the steel mills became able to roll larger and thicker sheets, this type of boiler increased in size and ability to carry heavier steam pressures, so that one single ended four-furnace boiler 17 feet in diameter can now be built to generate steam at 200 pounds per square inch sufficient for an indicated horsepower of 1,200 or more, although three-furnace boilers for a working pressure of 160 to 180 pounds are the common size. This type of boiler can be used to burn either coal or oil, and, like the reciprocating engine, is so well known that a breakdown in service is rare, although repairs on account of carelessness are not as infrequent as they should be.

The watertube boiler was introduced in the merchant service about 25 years ago, and has been used quite extensively recently, especially in connection with oil as fuel. It is considerably lighter than the Scotch boiler, but, on account of the small amount of water contained, it requires more care in operation. The Scotch boiler has nothing to recommend it theoretically, but its reliability keeps it in use, and, like the reciprocating engine, it is likely to be installed in cargo vessels for many years yet.

The fuel used in cargo vessels until quite recently was bituminous coal. Anthracite coal was discarded after a few years of use, as it was found to be more difficult to adapt to the varied requirements of service. Many cargo vessels do not have artificial draft, but quite a number of coal burners are fitted with heated forced draft, introduced by James Howden in 1884. Since the advent of fuel oil, its use on board ship has been extended so that very few vessels of the present day are designed for coal burning, although the greater number of the vessels afloat still burn coal. The tramp and the liner are both dependent on fueling stations. Very few vessels carry enough fuel for a round trip, and some of the routes are so long that fuel must be taken on at an intermediate station. The United States has about 21 commercial fueling stations at which oil can be obtained, in addition to its home ports. England has numerous coaling stations scattered over the world, but fuel oil is not obtainable except at a comparatively few ports, so that tramp steamers cannot use oil with satisfaction. At first, steam was used to atomize the oil, but that method was found unsatisfactory on account of the waste of fresh water involved, and at present the oil is heated to vaporizing temperature and sprayed mechanically. Heated forced draft is used to burn the sprayed oil, in most cases, and very satisfactory economy is obtained .

> Under ordinary conditions the United States cannot build and operate vessels as cheaply as some other nations. To overcome this difference, at present probably about 50 percent, a subsidy would accomplish the purpose, but a subsidy is liable to abuse and has not as yet been recognized as proper by the nation at large. Discriminating duties would accomplish the purpose in part but would help only on vessels importing dutiable articles. Discriminatory tonnage dues would supplement the discriminating duties and would apply to all vessels entering or leaving our ports. Tonnage dues are the nearest equivalent to a protective tariff and could be regulated to a nicety to enable our country to have such a merchant marine as our independence requires, without placing any more burden on any section of our people than has been imposed by the tariff.

The Load Line

Ships are built to stay at sea in stormy weather, and their structure must be strong enough to withstand wind and wave. In the days of the wooden ship, the effect of storms was shown first in the working of the seams, and pumping had to be resorted to regularly to keep down the leaks. In steel ships, the strength of the bottom of the vessel is usually greater than that of the deck, and the riveted seams do not leak so easily, so that except in old vessels a defect of strength was indicated by the posting of the vessel as missing. The stresses in a vessel are greatly increased if the vessel is overloaded, but the effect of overloading is not felt except in a storm. It was some time before this fact was properly appreciated, and a limit to the loading was found to be necessary for the safety of the vessel.

In the United States, there is no legal enactment to prevent overloading, although a committee has been appointed by the Secretary of Commerce to formulate recommendations. A British committee has recently proposed a modification of their freeboard tables basing the loading on an absolute criterion of strength, so that the stronger a vessel the deeper she will be allowed to load. With proper precautions as regards the tightness of hatches and the safety of movement of the crew, this would seem logical. It is hoped that our Government will afford a similar measure of protection to the humble cargo vessel. In the matter of loading, the stresses increase more rapidly as the draft increases, and even a foot of overloading is likely to strain the structure in a storm, and if persisted in to cause the loss of the vessel.

Under ordinary conditions the United States cannot build and operate vessels as cheaply as some other nations. But we can afford to carry our own commerce, just as we could afford to do our own manufacturing. Our independence requires that we shall do our own carrying, and we must not fail to arrange for so doing.

How did we build up our manufactures? We did not buy other nation's manufactures just because they were cheaper than ours, but we put on a tariff that enabled us to compete with foreign goods and to build up our own industries. We must do the equivalent with ships. How? A subsidy would accomplish the purpose with us, as it has with other nations. But a subsidy is liable to abuse, and has not as yet been recognized as proper by the nation at large. Discriminating duties would accomplish the purpose in part, but would help only on vessels importing dutiable articles. Discriminatory tonnage dues would supplement the discriminating duties, and would apply to all vessels entering or leaving our ports. Tonnage dues are the nearest equivalent to the protective tariff, and could be regulated to a nicety to enable this country of ours to have such a merchant marine as our independence requires, without placing any more burden on any section of our people than the tariff did, and could be removed in whole or in part if our cargo vessels, like our manufactures, ever reach the stage of development when no protection is needed, or when all the rest of the world has the same scale of living as ourselves.

The difference in cost of operation is so great, averaging at present probably fifty percent more than our competitors', that to balance the difference in freight rates required to offset the extra cost of operation the amount of discrimination in duties, and the difference in tonnage dues, will have to be quite great for awhile at least. The money which reverts to the Treasury on account of the increased tonnage dues on foreign ships will have to be paid out in some form of subsidy, also, as the vessels engaged in long distance trading and making few entries in a year will need as much assistance as the vessel making many round trips in the same time. The foreign vessel will not have to increase its freight rate appreciably on account of the increased dues, so that the American vessel will not be able to recoup itself for the increased cost of operation on the long voyage by an appreciable increase in the freight rate; and this increased cost must be met by some form of subsidy. The details can be worked out, however, without much trouble, if the American merchant marine is recognized as a national problem and treated as a matter affecting the welfare of every citizen, as it should be treated.

The Effort to Stamp Out Commercial Bribery

BY WALDON FAWCETT

Two mighty forces are at work in the United States to put an end to the orgy of "graft" in connection with the repair and the outfitting of ships that has been for, lo, these many years a reproach to all concerned. That tangible results from this crusade have already been made manifest, particularly at the Gulf and South Atlantic ports, is not the least gratifying feature of the situation. Shipowners who "pay the bills" have, therefore, reason to cherish the hope that they are, at last, to be relieved from a most irritating form of extortion.

Of the two influences that are co-operating, as it were, to purge the ship supply trade of its unholy practices, the most potent is that governmental institution, the Federal Trade Commission. The Trade Commission is sometimes referred to in the public press as "the supreme court of business." In reality it is a business policeman as well as a business mentor. Charged with the administration of the Clayton Act and the Federal Trade Commission Act, this censorial body at Washington undertakes to strike at "unfair trading" in any form, wherever it raises its head. "Complaints," or summons to defend suspicious practices, are served upon individuals and corporations who appear to be transgressing the code of ethical competition, and unless a cited concern can justify its course the complaint is likely to be followed by an order of the Commission to "cease and desist."

During its comparatively brief career the Federal Trade Commission has uncovered in the business world certain practices which, instead of being individual transgressions, constitute evils or unwarranted indulgences so widespread that it has appeared necessary to inaugurate wholesale drives to clear the commercial atmosphere. Most flagrant of the sores revealed is that of "commercial bribery" or "graft" forms of selling and contracting. Commercial bribery appears in various guises, but commonly it consists in the payment of cash commissions, the gift of cash bonuses, the bestowal of valuable presents or the furnishing of costly entertainment to buyers, employees, subordinates and others who are in a position to dictate where purchases shall be made or at least are enabled to recommend in what quarter trade shall be placed.

Questionnaires Issued

Setting out to scotch commercial bribery wherever found, the Federal Trade Commission had not proceeded far ere it discovered that the ship outfitting and repair field harbored not only the most flagrant examples of persistent and habitual graft, but the most widespread existence of the evil. It was solely, therefore, because here was the greatest need for reform, and not through any prejudice or unworthy motive, that the Trade Commission has concentrated upon the cleansing of the ship supply and repair business. Some sixty ship chandlery, repair and supply firms have already received black marks from the business umpire; and the end is not yet, unless there is widespread voluntary reform.

Two rather prominent firms are, it should be noted, resisting the efforts of the Trade Commission to raise the standards of ship outfitting and maintenance. So much so, that they have "carried up" to a United States Circuit Court of Appeals (as they are privileged to do under the law) the question of the right of the trade body to call a halt on the bribery of vessel masters, engineers and others who exercise the right of specification or purchase. This effort to stay the hand of the Federal reformer has not served, however, to retard the campaign except in the jurisdiction of the Fourth Circuit, where the issue of the authority of the Commission has been thrown into court.

Graft, a Custom of Long Standing

The only defense possible to the maritime bribers consists in the dual apology that the giving of "graft" represents a custom of long standing in the industry and that it is justified by the conditions as regards the remuneration of ship officers, etc. The Federal Trade Commission considers the first no excuse at all. It believes that the second is no extenuating circumstance in so far as the American merchant marine is concerned. There is evidence to show that certain classes of foreign shipowners, who pay or have paid in the past comparatively low wages to their masters, engineers, stewards, etc., have winked at the acceptance by these employees of gifts

and allowances from repair and supply concerns—"extras" that, in effect, went to make up for the deficiencies of regular pay. In the estimation of the U. S. Government investigators this excuse, if acceptable anywhere, does not apply to officers and employees in the American merchant marine who, in all cases, receive outright from the owners pay that is commensurate with their services.

What, more than all else, however, has spurred the Federal Trade Commission to action in behalf of cleaner conditions is the appalling evidence that has been unearthed as to the proportions of this evil. It is doubtful if any steamship operator or executive of a shipping corporation, however well informed, has any conception of the extent of this thinly veiled scandal. In the summons served by the Federal Trade Commission upon maritime bribers it has usually been cited that the offending concern was guilty of giving bribes in the form of a commission of 5 percent upon purchases. But that figure of 5 percent was used simply because there is, in certain circles, a pleasant fiction to the effect that 5 percent is the universal, standard perquisite of the men who make purchases for vessels. Accordingly the defendants have usually been willing to admit that they pay 5 percent. And, for the purposes of the Commission a bribe of 5 percent is as effective a basis for action as a bribe of any other proportions.

Five Percent a Minimum

That 5 percent is a minimum in bonus giving, rather than an average, was, however, the discovery of the Trade Commission's investigators who, incident to the proceedings thus far undertaken, have made examinations of the books of about 225 ship chandlery, outfitting and repair concerns located on the Atlantic and Gulf coasts. It was found that the giving of commissions of 20 or 25 percent is frequent; that commissions of 30 percent are not unusual; and isolated instances were found where commissions of 100 percent were actually paid in ship supply transactions. That the average is well above the 5 percent, that some interests would have shipowners believe is the maximum, is illustrated by the evidence obtained by the Trade Commission against a ship chandlery concern in New Orleans, engaged in selling steward's supplies, deck, engine and cabin supplies. It was found in this instance that the valuable gifts, cash gratuities and entertainments given by the seller cost, in the course of a year, in excess of $24,000. In other words the "graft" in this instance represents approximately 8 percent of the firm's entire volume of business, which averages $300,000 per year.

Deficiencies in Quality and Quantity

The eyes of the Trade Commissioners have likewise been opened to the appalling cost of this commercial bribery to the ship operators and the men who pay the bills. Ship outfitters have repeatedly told the Commission that buyers for ships have shown comparatively little interest in the quality of merchandise furnished and absolutely no regard for the prices paid so long as they had assurance that their demands for a "rake-off" would be met. Obviously, though, the addition to the cost of selling must be taken care of by the ultimate consumer and the Trade Commission has found that this fraudulent margin has been passed on to the shipping interest that pays the bills through such expedients as "fake" invoices, short weight, overcharges, short measure, and every other form of addition or subtraction that might be made to serve the purpose.

Even less appreciated, perhaps, by practical shipping men than the extent of the grafting operations and the means of covering the tracks, is the moral effect of this system of selling. The Federal Trade Commission has stumbled upon a scandal that can scarce be credited. The undermining of the morals of men who are constantly receiving or giving bribes is logical and is alone sufficient to condemn the practice, but there is another and darker side to the picture. The Trade Commission has found that whereas a majority of the vessel masters who accept "remembrances" want theirs, as one claimant put it, "in cold cash"; there is a considerable proportion who, upon arrival in port, bluntly put it up to the ship outfitter that they be wined and dined and "shown the town." Some of the evidence of what has been demanded and accorded along this line would be likely to startle the most sophisticated ship operator. And the Trade Commission's investigators found that such rounds of "entertainment" not only have a bad effect upon the efficiency of those entertained but are apt to have undesirable reaction upon the morale of the entire ship's company.

Beginning with the war-time episode when the United States Food Administration, on the recommendation of the Federal Trade Commission, put out of business an open-handed ship chandlery concern, with branches in a number of Atlantic Coast ports, the government has been steadily disciplining every ship service interest as to which conclusive evidence of bribery can be obtained. And just here it should be whispered that the bribery is by no means confined to the ship chandlery concerns, that are accounted its most conspicuous exponents. At the end of March, 1921, complaint was entered against a machine works, located at New Orleans, which has been regularly allowing to ship engineers and other officers gratuities amounting to 10 percent of their repair bills. Most surprising to some of our readers will be the revelation that shipping agents are, in some instances, similarly implicated. That is to say the Trade Commission has unmasked shipping agents who, ostensibly representing vessel owners, are in the habit of receiving commissions from both parties to transactions.

Special Legislation Proposed

Effective as has been the work of the Trade Commission with the weapons at hand, it is desired to make it yet more effective and to that end there is an effort in Congress to provide special legislation that will strike specifically at "commercial bribery." The 67th Congress of the United States will have before it, with this objective, two legislative proposals. One will be a bill—a revised edition of a measure that was considered by the Committee of the Judiciary of the United States House of Representatives only a few weeks ago—which undertakes to penalize "commercial bribery" in all lines of business. The other bill will be a special or specific measure designed to prohibit the payment of gratuities to the masters of vessels or other persons for the purpose of inducing or securing contracts for repairing vessels or furnishing vessels with supplies or other necessities.

The movement to secure national legislation that will, in effect, strengthen the hands of the Federal Trade Commission in its reform campaign, is interesting in itself but it is even more interesting as a background for a widespread drive for satisfactory State legislation to this same end. Some fifteen or sixteen States of the Union have on their statute books at the present time laws designed to put an end to graft in ship outfitting and repair operations. Lax enforcement or non-enforcement has served to all but nullify the force of such law, as witness, for example, the spectacle of six prosecutions and one conviction in New York State. Putting all the blame possible on the laxity of the officials whose duty it is to enforce the law, there remains the fact that many of the State statutes are faulty and inadequate. To correct this the States are being urged to enact what is accounted a "model" commercial bribery law. The State of Louisiana has, within the year, adopted this law, and its working in what was once a hotbed of bribery in shipping operations will be watched with interest.

Business Firms Revolting

The opening months of the year 1921, witnessed the advent of a new influence for higher ideals in ship service

practice that seems destined to match the Federal Trade Commission in achievements, albeit the attack is from the opposite angle. This new element is eloquent of a spirit of revolt and reform within the ship outfitting trade. There have been, always, a minority of ship repair and ship supply firms that resented the customs of bribery that obtained. In a few instances the anti-bribery men have defied their competitors and have steadfastly refused to grant "graft" when demanded. Usually, however, such show of independence has been possible only to machine shops, wholesale grocery firms, wholesale hardware houses and other supply concerns, only a portion of whose business has been derived from the ships. The majority of the service concerns that depend wholly upon ship trade have had to bow to what seemed inevitable custom, regardless of how little they relished the idea of paying for favor.

With the Federal Trade Commission resorting to compulsion, however, and seeking to arouse the public conscience to the point where Congress would enact a special law, the worm turned. A group of ship supply firms at New Orleans and Gulf ports got together in inauguration of a movement to have the trade undertake its own housecleaning. These pioneers formed the nucleus of a new organization, the avowed purpose of which is to remove the taint of bribery from the ship service trade. The best augury for the success of this unique and praiseworthy undertaking lies in the fact that its active management is in the hands of Mr. C. E. La Vigne, who was, until recently, an examiner of the Federal Trade Commission and to whose lot, in that capacity, it fell to make the investigation of bribery practices in the ship service field. Knowing in intimate detail all the iniquities of the system, Mr. La Vigne should be qualified to lead a volunteer movement for emancipation.

Protective Organization Formed

Forty-eight representative ship supply and ship service firms in the territory from Norfolk to Galveston were invited to become charter members of the organization which has, as its avowed object, "the protection of steamship owners purchasing supplies and repairs." Every one of the forty-eight accepted. Theoretically or sentimentally this new body would be accounted a trade association but, considering the purpose in view, it was desired to infuse a stronger element of responsibility, and, accordingly, incorporation papers have been taken out under the name American Ship Service Corporation, with offices in Washington, D. C. The scope of the organization will be in no sense sectional. Members have been enrolled in New York and New England and the campaign for membership will be extended, as promptly as may be, to the Pacific Coast and the Great Lakes.

Absolute good faith and sincerity in intent to eliminate commercial bribery and other evils and abuses in the shipping field is claimed for the new institution. Every dealer, outfitter, or repairer who is admitted to the American Ship Service Corporation is required to sign a pledge as follows: "Membership in this corporation carries with it the understanding and pledge that no gratuities, systematically lavish entertainment, so-called commissions, or other thing of value will be given to any person whatsoever, directly or indirectly, to influence the placing of orders in connection with the shipping business." It is promised that disregard of the pledge in any instance will be followed by the summary expulsion of the offending member and publication of the circumstances of the expulsion. The circumstance that the American Ship Service Corporation is not only working for voluntary reformation of the trade, but is likewise most active in the effort to induce Congress to enact an anti-bribery law holds hint that the new organization may have it in mind to aid in disciplining ship service firms that persist in indulging "grafters."

In conclusion it may be said that there is a feeling at the Federal Trade Commission and among conscientious ship service men that conditions in the shipping industry have become such, latterly, that ship operators may do much to prevent graft by the officers on the ships to whom they have to delegate purchasing authority. There are vessel owners and executives of steamship companies who have long been bitterly opposed to the acceptance by masters, engineers, shipping agents, etc., of commissions from supply firms or service concerns and who have endeavored to make contracts that would forestall such exploitation. But during recent years it has been extremely difficult if not impossible to find protection. Officers for ships have been in demand and the ship operator has been in no position to dictate unusual terms. Ship service concerns that desired to play fair have been similarly handicapped. Indeed, one concern lost in one year $170,000 of contract business because it would not bow to the demands of men on the ships who proposed to have their perquisites or take their business elsewhere regardless of the fact that they were supposedly bound by contracts of the owners. Latterly, however, the supply of available ship officers exceeds the demand. Owners and operators are in a position to pick and choose. Hence they have opportunity to make contracts with ship service concerns committed to the no-bribery platform, with confidence that such contracts will be observed.

American Marine Insurance Syndicate "A" Expands Its Organization

In order to meet the requirements of the United States Shipping Board for the making of periodical condition surveys, heretofore made by the United States Bureau of Survey, Syndicate "A" of the American Marine Insurance Syndicates has found it necessary to extend its organization both on the Atlantic and Pacific coasts. The manager, Mr. Page, who has just returned from the Pacific coast, reports having established offices at both San Francisco and Seattle.

The former port will be the headquarters of the California district, comprising all California ports, and will be in charge of Mr. David O. Young, an experienced marine engineer, well known to all shipping and insurance men of the Pacific coast and particularly to the San Francisco district, where he was the manager for some years of the Hanlon Drydock & Shipbuilding Company.

The Seattle office will be the headquarters of the Northwestern district, comprising Oregon, Washington and British Columbia. Through the co-operation of the Board of Marine Underwriters of San Francisco the Syndicates have named Captain S. B. Gibbs, agent of the San Francisco Board at that port, as agent of Syndicate "A" as well. Captain Gibbs is well and very favorably known to the shipping and underwriting world, having served the San Francisco Board at Seattle for twenty years past.

Mr. Page also reports that it has been found necessary to extend the Syndicate's organization on the Atlantic coast by the establishment of offices at Boston, Norfolk and Savannah.

The Boston office will be temporarily in charge of Mr. J. A. Wilson, detached from the New York office for the purpose.

The Norfolk office, with jurisdiction over Newport News also, will be in charge of Mr. J. T. Christie, an experienced marine engineer and formerly manager of the United States Bureau of Survey at that port.

The headquarters of the South Atlantic district have now been transferred to Savannah and Mr. M. H. Winner, formerly manager at that point of the United States Bureau of Survey, has been put in charge. This district will exercise jurisdiction over all ports from Wilmington, N. C., to Tampa, Florida, inclusive, Pensacola having been added to the jurisdiction of the New Orleans office.

The Importance of Marine Insurance

BY "OLD SCOTCH"

The insurance charge on an operating merchant vessel is one of the heaviest with which shipping men have to contend. It is also one of the most complicated and intricate subjects to understand. Many tomes have been written on the subject by expert underwriters, and the average man interested in shipping, having read the literary effusions of these experts, shakes his head and generally admits being no wiser than he was before. He will, however, agree with me that it is a complicated subject. I am going to admit that my knowledge is about the same as Mr. Average Man's. I have, however, had opportunities of discussing the subject with many of the best underwriters in the business and have formed my own ideas, crude as they may appear to the initiated, so here they are.

THE man or company who risks his money on the safe arrival at a distant port of a structure known as a ship is a gambler of a legitimate type. His methods in fixing the odds for the proposed marine risk are very much akin to those adopted by the shrewd bookmakers, generally of the Hebraic persuasion, who in the end take your money away from you at a horse race. He may, and very often does, lose on particular bets placed on particular ships, but at the end of the year he has won often enough to pay his losses and submit an income tax return showing that he has made a good livelihood during the season. In the course of a number of years he has, in proportion to the shrewdness and intelligence he has applied to his vocation, either gained a competency or gone broke.

Anyone who has indulged in the so-called "sport of kings" knows that the bookies who tempt the money out of your pocket by the alluring odds they display on each race have arrived at their conclusions by no haphazard methods, but from the knowledge born of experience. They must be capable of sizing up the contesting horses, studying their pedigrees, get all the obtainable "dope" of recent performances, investigate the jockeys to learn of their honesty, habits and weaknesses, and very quickly weigh all attending circumstances in order to announce the odds they are willing to risk on each animal in the race. They must be constantly studying everything that is pertinent to the game which they are playing and investigate every rumor they may hear which is at all relevant to the forthcoming race.

How the Odds Are Determined

In marine insurance the gamble is on the particular ship in her contest with the elements in the guise of storm, current and fog, strandings, collisions and fire. To arrive at the odds he will place on the risk the underwriter must carefully study the pedigree of his ship. How old is she? Who built her? What materials were used? Was she carefully designed by competent people? How has she been cared for? What is the latest dope on her condition at the hour of sailing? Is she loaded properly, etc., etc.? In fact, everything pertaining to the construction of the ship must be carefully weighed and constitutes an important element in determining the rate. Bookmakers use "dope sheets" for the horses, and underwriters use the "dope sheets" or classification society publications for the ships.

Past performances are just as important to the ship underwriter as similar dope is to the bookmaker. Careful account is kept of all losses incurred by the particular ship, the particular line operating her, the particular group to which she belongs, and the particular trade in which she is employed. "The record of the past is the best harbinger of the future" is essentially the general principle guiding the fixer of marine insurance rates.

The moral risk is another very important factor, and by this is meant the efficiency of the personnel, both on shore and at sea, operating the craft. The records of the skipper, the first mate and the chief engineer are just as essential to the ship underwriter as is the record of the owner and jockey operating the particular horse in a race to the bookmaker. Even the element of luck enters into the problem. Some operating lines and some skippers have records of being lucky in their undertakings, others are proverbially hoodoos and bad luck seems to attend their efforts wherever they go, or is liable to result at any time.

Group insurance, or fleet insurance, as it is more properly termed, of assuming a cover for the entire fleet of a particular company for a year at a time is sometimes materially affected by the general reputation of the operators, and in one instance I have heard of by the particular reputation for efficiency of a marine superintendent. This particular official probably did not know it, or otherwise he might have struck for more salary, but a certain American line of steamships was recently given a preference of one-half of one percent on a fleet insurance for a year because the new marine superintendent which they had employed was considered by the underwriters as a particularly able man in the conduct of his functions in operating the ships.

The Personal Equation

The personal equation is one of great importance to underwriters, for even a good ship commanded by an incompetent skipper or the machinery in charge of a careless engineer makes a bad risk for the underwriter. The converse is also true, so that underwriters have a right to know something about the men who are in charge of the ship on which they stake their money. The simple fact that an officer is licensed by the Government is no guarantee that he is the man whom the underwriters are willing to rely upon to have responsible charge of property at sea on which they take a risk.

The shipping community around New York has recently been much interested in some circulars issued by a prominent American steamship company giving reasons why their ships cannot be operated during the present period of depression. By a simple statement of all actual costs to them of all charges except office salaries and expenses, depreciation, interest and other capital charges, it was demonstrated that in the operation of one of their ships to the River Plate at going freight rates they would lose $16,192 on a round trip. Of the items of expense listed the sum of $9,032 was chargeable to insurance for a period covering one round trip only, or 120 days. This, too, was based on a value of only $60 per deadweight ton, whereas the ship in question was built only two years ago, and probably represents an actual capital charge to the owners of not less than $200 per ton. The entire wage charge for this ship for the period of 120 days was $18,760. Had the vessel been insured for her actual value, this item alone would have been far in excess of the total cost of wages of officers and crew. These figures are quoted simply to give an idea of the great importance of insurance to our merchant marine.

Up to 1918 over two-thirds of all insurance in our merchant ships was placed in foreign markets. We thus were

practically at the mercy of our competitors, and this fact acted as a club on our entire foreign trade. Foreseeing the absolute necessity of our creating a market in this country whereby the greater part of our insurance could be kept in our own hands, the leading American underwriters have banded together for co-operative assistance. They have received the sympathetic support of the Federal government in every way possible, and an earnest effort is now being made to pass uniform insurance laws in the several states whereby American companies will have at least an even chance with their robust and experienced foreign competitors. They have been taxed without regard to the profits they made, and foreign companies have been able, in many instances, by devious ways to avoid certain local taxes in this country which the American companies have been compelled to pay.

American Marine Insurance Strongly Supported

The American companies are co-operating by means of what are termed American Marine Insurance Syndicates A, B and C. Syndicate "A" is purely an inspection and salvage association, to which the United States Shipping Board has contributed one million dollars to be used as capital, with the inevitable string on it, however, that it must be paid back to the Government by January 1, 1924, after deducting all legitimate charges incurred in accordance with the agreement entered into by the syndicate. Out of this syndicate will gradually come what is known as the United States Salvage Association, to be conducted along the general plan of the well-known London Salvage Association. In fact, this new association has already been chartered and will be conducted on a non-profit basis in all parts of the world for the benefit of genuine American underwriters. By this means all claims for losses, surveys and necessary repairs will be in strictly American hands, and should result in a considerable curtailment of the losses to which American companies might otherwise be subjected.

Syndicate "B" has now been functioning very satisfactorily for over six months. Its object is to insure all American steamships owned by the Government, and the unpaid portion of such ships as may have been sold by the Government. The facilities of the various American companies comprising this syndicate are such that no less than $2,000,000 may be placed upon any single ship.

Syndicate "C," composed largely of American companies but having some admitted foreign companies, will place insurance on any American ship and has facilities of $2,500,000 on any single American ship.

Generally speaking, the rates granted by these American syndicates are slightly in excess of the prevailing foreign rates, but as the overhead is gradually reduced and the "dope" of experience is accumulated it is expected that in the near future American rates will be as low as any.

Aside from the great national advantages accruing to our foreign trade in the control of the bulk of our marine insurance on both hulls and cargoes, the fact must not be overlooked that several hundreds of millions of dollars paid in premiums, and heretofore annually sent abroad to enrich the coffers of our competitors, will be kept within our own borders.

Bearing these facts in mind, we must all take off our hats to the American underwriters and wish them all success in their real competition with the experienced and financially strong rivals across the waters. Their success will be a most important element in the future success of our merchant marine activities. A well-known American writer very ably summarized this subject by stating:

"Marine insurance bears to commerce the relation of bodyguard rather than merely servile attendant . . . Of the active forces which influence, control or forbid the employment of shipping, none has greater effect than the marine insurance power."

Notes on the Motorship Zoppot

THE German motorship *Zoppot,* which was built by Fried. Krupp, A. G. Germaniawerft, Kiel, Germany, and launched January, 1914, has just undergone minor repairs at the Robins Dry Dock & Repair Company, Brooklyn, N. Y.

This vessel, which has completed seven voyages across the Atlantic without a single stop, has been chartered by the Standard Oil Company of New Jersey. Her principal dimensions are as follows:

Length	525 feet
Beam	66 feet 3 inches
Depth	41 feet 3 inches
Draft	27 feet 9 inches
Gross registered tonnage	9,600 tons
Net registered tonnage	5,700 tons
Displacement	22,000 tons
Cargo carried	14,200 tons
Bunker oil	800 tons

The *Zoppot* is a twin screw vessel propelled by two 4,400 indicated horsepower Krupp-Germania Diesel engines of the 6 cylinder, 2 cycle, single acting type. The engines are directly connected to the propeller shafting, which revolves at the rate of 106 revolutions per minute.

Fuel Consumption

The fuel oil consumption on a round trip between Baton Rouge to Hamburg and return, a distance of 10,600 miles, was 600 tons of 2,205 pounds to the ton. The actual time consumed on this trip was 43 days and an average speed of 10.36 knots was maintained.

The lubricating oil consumption is 30 gallons per day of 24 hours. The gravity system is used and the same lubricating oil having a viscosity of 5.1 is used for both cylinders and bearings. After passing through the engine bearings, cylinders, etc., it is collected in the bedplate and drained to a cell in the double bottom, whence it is pumped through filters to the gravity tanks.

Most of the auxiliaries are driven by steam which is furnished by two donkey boilers. The fuel oil consumption under the boilers at sea is about 2½ tons per day and in port when loading or unloading at full capacity, about 9 tons.

Diesel Electric Drive to be Installed on Ocean-Going Freighter

THE first ocean-going freighter in the United States to be equipped for Diesel oil engine electric drive will result from contracts recently signed between the Todd Shipyards Corporation and the American Mediterranean Steamship Company calling for the conversion of the motorship *Fordonian,* a 2,200-ton vessel, for which the General Electric Company, will furnish the electrical apparatus.

The *Fordonian* is a single screw freighter 257 feet long, 42-foot beam and 26-foot draft, with a deadweight tonnage of 2,200 tons. Her new equipment, which will be installed at the Tebo Yacht Basin of the Todd Shipyards Corporation, will consist of twin Ansaldo San Giorgio two cycle, four cylinder Diesel engines direct connected to two 240 kilowatt, 250 volt, 200 revolutions per minute compound wound direct current generators. The generators will furnish power to a double armature, pedestal mounted, 850 brake horsepower, 120 revolutions per minute motor, which will be directly coupled to the propeller shaft.

The electric auxiliaries furnished by the General Electric Company will consist of one 6 kilowatt volt motor generator set for lighting, one motor-driven blower for ventilating the propeller motor, and three pump motors. These include a 5 horsepower motor driving a 5 by 8-inch vertical triplex single acting fuel oil pump and a 10-horsepower motor driving a 6 by 8-inch vertical Rumsey single acting fire pump.

Motorships Not Being Laid Up

While the Shipping Depression Lays Up Large Number of Steamers, All Motorships Continue in Profitable Operation

BY OUR SPECIAL LONDON CORRESPONDENT

PROBABLY nothing has struck the imagination of British shipowners more than the fact that while large numbers of steamers are now being laid up, all motorships continue on their ordinary trading routes, apparently at considerable profit to the owners in spite of the slump in freights. One of the best examples for the economy of the motorship, which incidentally was not lost on British shipowners, was the recent inaugural voyage of the Johnson Line motorship *Buenos Aires* from Vancouver through the Panama Canal to London, carrying a cargo of Canadian wheat. This ship which is one of a fleet of nine or ten internal combustion engined vessels owned by the same firm, and which has a deadweight capacity of 9,300 tons, is able to carry this cargo on a fuel consumption of 10½ tons per day at a speed of eleven knots, whereas the corresponding steamer would consume about 50 tons of coal.

The service is only an economic proposition for a motorship, since the steamer would have to pay too much for its fuel in order to make a profit on the voyage. The arrival of the *Buenos Aires* and the economy indicated were very well heralded in England, with the result that even more attention has been paid recently to the possibilities of the motorship than before. What is particularly significant from the technical standpoint is that the *Buenos Aires* is a standard ship in every detail and is one of perhaps a dozen similar craft now in service, fitted as she is with Burmeister and Wain machinery of 3,100 indicated horsepower. This policy of standardization on the part of different owners and builders is certainly one of the most extraordinary features of motorship development and it is now possible to find motorships owned and built by British firms which are sister ships to other craft owned and built by Scandinavians. The latest vessel for the Johnson Line, which at the time of writing is on her maiden voyage, is also a sister vessel to the *Buenos Aires*. This is the *Canada*, which was completed in Gothenburg at the beginning of March.

Repair Facilities on Motorships

In all of these standard motorships, one of the features which catches the eye of the engineer on an inspection of the engine room is the excellent arrangements which are provided for carrying out all necessary repairs to the ship. Owners of motorships have found it is usually rather difficult to effect any repair work at many overseas ports and in any case it is often extremely expensive and badly done. They therefore consider it a profitable undertaking to install a somewhat elaborate workshop in the engine room, this being all the more advisable in view of the large amount of space which is available. In the average Scandinavian built motorship of the *Canada* type there is a moderate sized lathe, an excellent drilling machine, a grinding machine and a shaping machine all driven by belting from a little electric motor.

A New Vickers Engine

Although in almost every case British manufacturers of oil engines are standardizing their motors, nevertheless they are taking the opportunity of benefiting by the experience of the existing engines and making such modifications on the later sets as seem desirable. For instance, Vickers have entirely altered the control gear of their new engines compared with the first two sets which were installed in the motorship *Narragansett*. This alteration is significant and the fact that it is necessary should form a guide to marine oil engine designers in America. In this type of engine, which is a four-cycle motor with the usual Vickers solid injection, there are ahead and astern cams as usual, side by side on the camshaft which have to be moved fore and aft when reversing.

In the original arrangement the admission of compressed air for starting, and the control of the fuel valves for speed variation, were effected through a handwheel and the servo motor for moving the camshaft after lifting the valve levers in the cam was mounted on the front of the engine. The servo motor was put into operation by means of a hand lever and it was found that this combination of levers and wheels rendered the process of reversing somewhat arduous. The speed

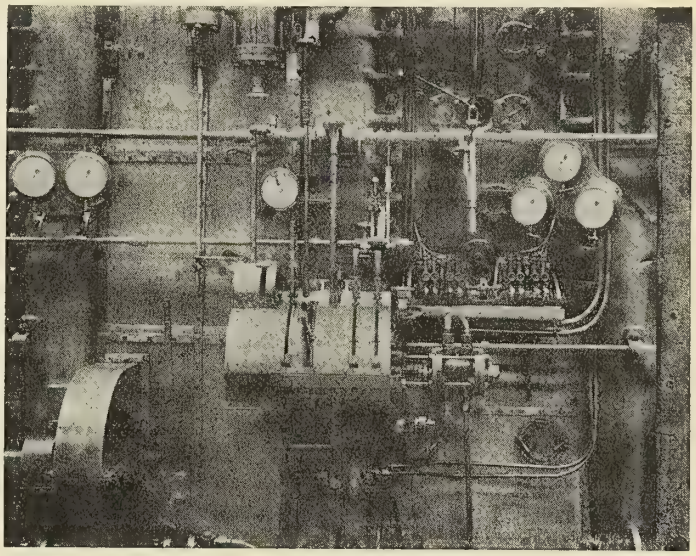


Fig. 1.—Control Station of 1,250-Brake Horsepower Vickers Engine

control is therefore effected by another lever corresponding to the reversing lever and the servo motor is removed from the front of the engine and placed at the top. The arrangement of the present control is clearly seen in Fig. 1 with the four levers; the one on the extreme right is for reversing while that on the extreme left is for starting, and the one adjacent to it for control of the speed by varying the lift of the fuel valves. The fourth lever is not normally in operation but is only used when the servo motor is out of action and the gear must be operated by hand. It will thus be seen that in maneuvering three levers have to be moved, the air starting, the fuel control and the reversing lever. It is rather surprising that the air starting and fuel control levers have not been combined, as they are in the Burmeister and Wain engines, which would then reduce the control virtually to two levers instead of three. Nevertheless the speed of reversing in the new Vickers engine is certainly remarkably good.

Many New Motorships

A series of extremely interesting launches has been effected during the past month or two. Included among the latest craft is the passenger motor liner *Magvana*, now rapidly approaching completion on the Clyde. It will be remembered she is equipped with a couple of the new type of 2,330 indicated horsepower North British Diesel engines and is for

the British India Steam Navigation Company, being designed to carry about 10,000 tons of cargo in addition to passengers. Another ship recently put into the water is the 12,000 ton motor cargo vessel *Somersetshire* for the Bibby Line, a duplicate of the *Dorsetshire,* which since her completion has proved very successful.

A third craft of unusual interest is the *Malia* for T. and J. Brocklebank, also for the Eastern service, in which are being installed two of the new Camellaird Fullagar opposed piston oil engines. It is remarkable what a general belief there is in the possibilities of this new type of engine even among builders of competitive designs and it is perhaps significant that John Brown and Company, of Clydebank, is now building its first 2,500 brake horsepower set of this type. The Cunard Company is watching the developing with considerable interest and in view of its close connection with John Brown and Company, it would not be surprising if the Cunard Company ordered a fairly large boat fitted with Camellaird Fullagar engines in the near future.

It is a curious fact that the Camellaird Fullagar engine designers will have nothing to do with solid injection and retain the usual type of air compressor, although Doxfords, in their new engine in which the opposed piston principle is utilized, are employing solid injection at 9,000 pounds per square inch. The tests on the first 3,000 horsepower Doxford engine have been carried out over a prolonged period and apparently have proved all the manufacturers desired. The fuel consumption works out at about 0.43 pound per brake horsepower hour and the engine will operate satisfactorily on heavy Mexican oil, although of course this fact cannot be finally determined until the vessel in which the engine is being installed has been in operation for some months.

A great deal hinges upon this matter since shipowners are now asking shipbuilders for oil engines that will burn fuel oil as satisfactorily as Diesel oil and builders of Diesel motors are therefore paying a great deal of attention to the problem. It will no doubt be difficult of solution in the case of four cycle engines with their exhaust valves liable to be easily corroded with the heavier fuel, but with two cycle engines both of the opposed piston and single piston type there should be no insuperable difficulties.

Turbine Reduction Gears Versus Electric Propulsion for Ships*

BY ESKIL BERG†

THE question of whether electric or geared propulsion should be used depends entirely upon the type and operating conditions of the vessel. The Navy Department, after years of comparative study and having actual operating data on electrically propelled vessels available, has decided to equip all the larger Navy vessels with electric drive. In this type of ship, electric drive has a decided advantage as economical cruising speed (which is so important for this type) can be obtained, the machinery can be located in the most convenient place furthest removed from disturbances from gun fire or torpedoes, plurality of generating units can be used so that damage to one or more parts will not disable the vessel, and maneuvering can be accomplished more quickly and accurately, etc.

Geared turbine drive has an advantage in fast destroyers and light cruisers. In this type of vessel, the power is generally large and the propeller speed very high—factors which make ideal gear conditions. Geared turbines can here be built very much lighter than electric drive and, as the weight of propelling machinery in this type of vessel is of utmost importance, electric drive being heavier cannot be considered.

In merchant ships each individual case must be studied, and here the question of service, economy, reliability, weight and cost must be taken into consideration.

For fast passenger liners electric drive has an advantage. The transmission efficiency can be made practically equal to a conservatively proportioned double reduction gearing. It has, also, the advantage that the more efficient turbine can be built.

If two generating units are used, one unit will propel the vessel at about three-quarters speed with only slight sacrifice of economy. Noise, so objectionable in passenger vessels, is practically eliminated with electric drive.

In moderate power twin screw ships of about 6,000 to 8,000 horsepower electric drive has a decided advantage both in economy, weight and price if one turbo-generating unit is used to drive both propellers. In case this unit or any of its auxiliaries should become disabled, a simple arrangement can easily be made by which the ship could be run at low speed from the auxiliary generating unit which normally drives the electrically driven auxiliaries.

On the other hand, if two generating units are used, the equipment becomes slightly less efficient, the weight and cost also go up considerably, and the comparison then becomes similar to a 3,000 horsepower single screw freighter.

In the case of slow speed single screw freighters of 2,500 to 3,000 horsepower, the geared turbine is somewhat lighter. The actual transmission efficiency of the gears is also better. However, when the losses of the reversing turbine, power taken by the oiling system, packing losses, as well as leakage of steam due to larger clearances, are taken into consideration, the transmission efficiency is practically equal—if anything in favor of electric drive. If, however, the motor is located aft, doing away with long shafting with its expensive bearings, supports and shaft alleys, the electric drive is the lightest, cheapest and most economical, as well as the most reliable method to use. With the main auxiliaries driven electrically, the ship can by very simple arrangement be run home by power supplied from these auxiliary units should the main propelling machinery or its auxiliaries become disabled.

In freighters of 1,500 horsepower or less, geared turbines are lighter and cheaper. As the power is small, a gear can be designed which is less affected by sudden load variation or disalinement caused by springing of the hull or inaccurate workmanship.

The following is a list of electric propelling machinery now being built by the General Electric Company:

For the Navy	Horsepower of each	Total Horsepower
Three battleships, *California, Maryland, West Virginia*	32,000	96,000
Two battleships, *Iowa, Massachusetts*	60,000	120,000
Four battle cruisers, *Constitution, United States, Saratoga, Lexington*	180,000	720,000
Total		936,000
For Merchant Marine		
Eleven 3,000 horsepower freighters similar to *Eclipse*		33,000
Four 2,600 horsepower Coast Guard cutters, synchronous motor		10,400
One 3,000 horsepower United Fruit Company		3,000
Total		46,400

SHIPBUILDING RETURNS.—The Bureau of Navigation, Department of Commerce, reports 83 sailing, steam, gas and unrigged vessels of 145,852 gross tons built in the United States and officially numbered during the month of March. Of the total, 8 vessels of 51,029 gross tons were built for the United States Shipping Board.

ITALY PLANS NEW SHIPYARD.—A group of Italian banks has provided 66,000,000 lire for construction of a great trade and industrial port at Vade, in the Province of Liguria. In connection with this, at the mouth of the river Quilliane will be established a shipyard.

* Resumé of paper presented at joint meeting of New York Section of American Institute of Electrical Engineers and Metropolitan Section of American Society of Mechanical Engineers, New York, January 28, 1921.

† General Electric Company, Schenectady, N. Y.

Standardized Diesel Engines—III*

Description of Valve-in-Head Method of Scavenging for Two-Cycle Type Engine

BY H. R. SETZ

FIG. 15 shows a two cycle cylinder head and valve gear ready for immediate substitution in the framing of the four cycle engine shown in Figs. 2, 3, 7 and 8. The lower centering flange now becomes a water cooled exhaust belt and therefore performs a double service. The upper centering flange is identical with that used on the four cycle engine, as is the cylinder liner casting. Owing to the enlarged machined diameter provided near the lower end of the four cycle liner, all that is required to adapt it to the two cycle is the milling of the ports.

The cylinder head, of course, changes. It still consists in its elements of three flat disks joined together by the various cylindrical surfaces running perpendicular to all three and forming stud bosses and the valve cage pockets. The middle one of the three disks is the water deflector already described in connection with the four cycle head. A new feature, however, is the absence of any circumferential wall for closing off the interior of the head. This construction, which affords an extraordinary opportunity for good foundry work, is made possible because inlet air only—no exhaust—need be accommodated and because the cooling water is kept below the deflector diaphragm. Only at the center is the cooling water permitted to circulate upward in an annular space surrounding the fuel valve cage sleeve and to discharge through an opening in the top face. Ample area for guiding the scavenging air to the interior of the head is furnished by a light volute-shaped casting flanged to the air manifold and slipped over the outer cylinder head contour. Since the air is therefore merely guided between the roof of the cylinder head and the diaphragm which separates it from the cooling water, it encounters no appreciable resistances or velocity changes until it actually enters the valves. The valve cages are not placed in pockets, nor does their air supply come to them through passages. This particular cylinder head design therefore possesses all those features which make for a casting free from initial casting strains, a certain freedom to expand and contract and ample strength. The well directed uniform flow of the cooling medium around the four valve cage seats towards the center will be of even greater benefit here than in the four cycle head; it must be remembered that the period of cooling between consecutive heat impulses is only half as long in a two cycle engine as in the four cycle type and that the reduction in effective heat transmitting surface due to the openings for the scavenging valves is therefore always somewhat of a detriment in engines of this type.

Practically the entire four cycle valve gear can be used for this machine with the exception of the exhaust valves, which are replaced by two inlet valves combined with the top portion of the exhaust valve cages. Different gears must be used for the camshaft drive, while the camshaft itself, housings, fuel pumps with bearing brackets, eccentrics, push rods and valve cages are the same. The oscillating cam rods for the operation of the outboard valves, acting with their double cam on one moving and one fixed roller, make possible easy clearance adjustments as already pointed out. The rollers for the inboard valve spindles turn on an overhung gudgeon pin pressed into the forked operating lever. To adjust clearances here it

* Copyright, 1921, by H. R. Setz.

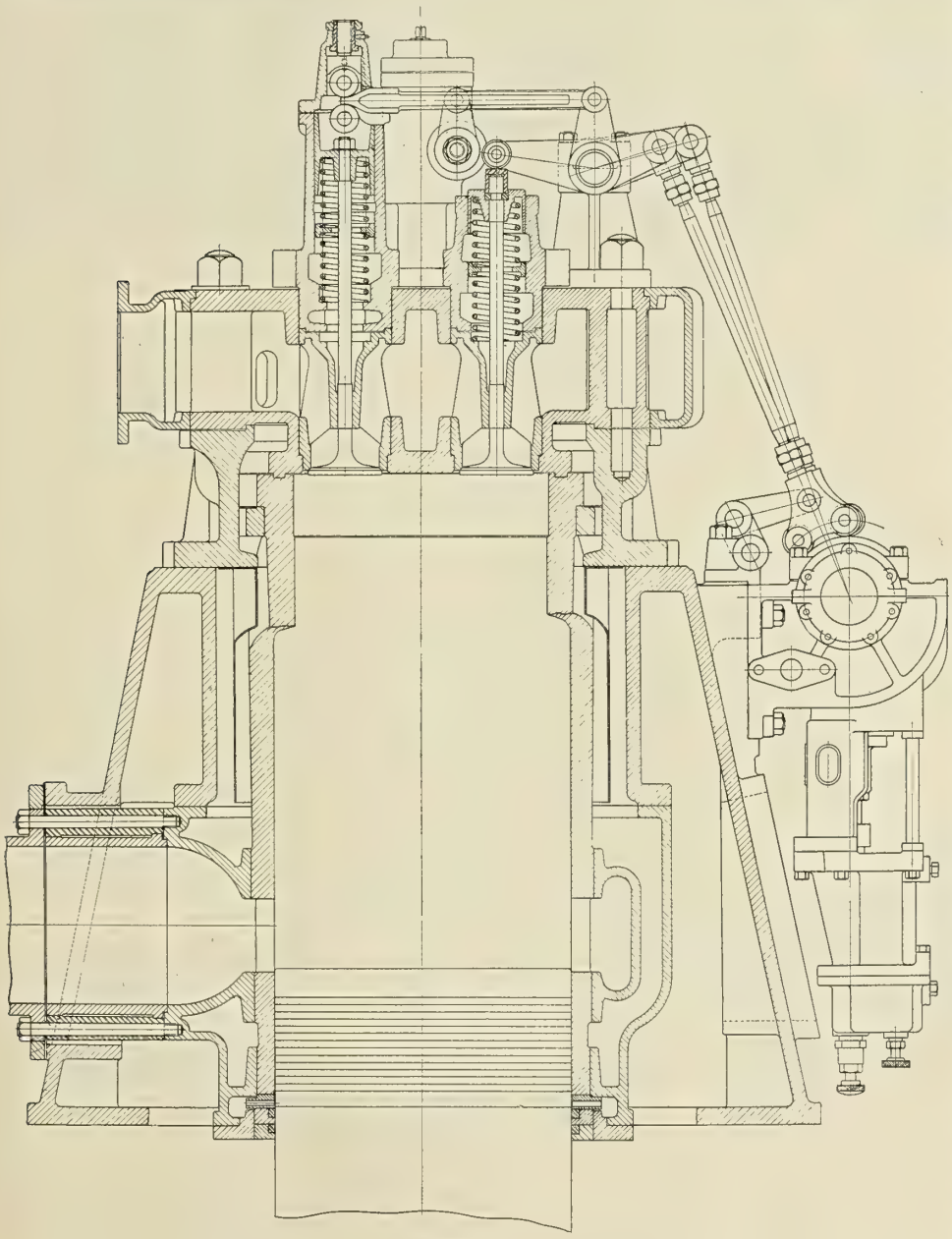


Fig. 15

is necessary merely to strip the roller off sideways, to raise the hardened tappet cap and to change the shims underneath it. The short push rods made possible by the favorable location of the camshaft, together with the light and compact rocker arm, result in a valve gear as well adapted for the particular operating conditions to be met here as is at all possible. Its ready accessibility furthermore facilitates the adjustments which engines of this type demand rather frequently.

Early two cycle engines in capacities of 1,000 horsepower and over were practically all of the valve-in-head scavenging type. In proper recognition of the importance of large scavenging valve areas, two, three and most generally four valves were used by different designers. None of these arrangements has produced results which are in every respect comparable with those of four cycle engines of similar cylinder size. Under severe operating conditions, particularly where the load fluctuates over a wide range, cylinder heads containing scavenging valves developed cracks after comparatively short operating periods. This was particularly pronounced on marine engines where extreme temperature fluctuations occur during maneuvering owing to the introduction into the hot cylinders of cold starting air. Special materials, such as manganese bronze and steel, have only deferred but not eliminated this cylinder head trouble and greatly increased the cost of such engines. But even if by careful design in regard to favorable material distribution and cooling as shown in Fig. 15, and through the elimination of air starting in the engine cylinder by the method previously described, cylinder head breakage can be prevented or greatly reduced, there still remain problems of no small practical consequence which weigh heavily against the valve-in-head principle.

The most tenacious of these is the valve operating mechanism. Since the scavenging valves are to open about 10 percent before and close about 25 percent after the lower dead center, their duration of opening extends over a crank angle of approximately 100 degrees, which at a speed of 125 revolutions per minute corresponds to .133 second. This is less than half the time available for operating these same valves in a four cycle engine and the valve lifts occur twice as often. Considering further that in the two cycle engine all these valves are lifted at the same instant, it can readily be appreciated that the kinematic forces which must here be dealt with are several times larger than in a four cycle engine of the same size and speed. This and the comparatively high frequency at which these forces do occur indicate the seriousness of the valve gear problem. Because of practical limitations, cam surface and pin pressures can hardly be reduced to magnitudes customary on four cycle engines, with a consequent rapid wear on these surfaces which require frequent adjustment. Probably the most serious effect, however, is the excessive wear on the gears driving the vertical and cam shafts. These being usually of helix form, they are extremely susceptible to violent and rapid load impulses and the very best of material and most carefully worked out and tended lubricating system cannot prevent appreciable wear. Adjustments on these gears for wear are extremely delicate to make. As a whole, therefore, the valve gear in its entirety for two cycle valve-in-head scavenging engines is difficult to control from a constructional point of view and delicate to handle under severe operating conditions, particularly in marine service.

For these reasons many other methods of scavenging and entirely new types of engines have been suggested and tried experimentally on a large scale which greatly broadened our perception and positive knowledge of the physical phenomena involved in the scavenging process and the mechanical means appropriate to their satisfactory control. The essential and conclusive facts which have come through this evolutionary stage are, first, that admission of scavenging air can be accomplished entirely satisfactorily by means of ports in the cylinder wall opposite the exhaust ports, and, second, that it is through this method of port scavenging that the enormous possibilities of the two cycle Diesel engine can be fully realized. Remarkable progress has already been made in this direction and the general engine structure previously described here permits of a further notable advance of modern two cycle engine construction.

(To be continued.)

Commerce Passing Through Panama Canal During 1920

THE *Panama Canal Record* gives the following data in regard to the commercial traffic passing through the Canal during 1920. It says: "Of the 11,236,119 tons of cargo shipped through the Canal in the year 1920, 6,124,403 tons, or over one-half the total, were shipped in whole cargoes, the respective vessels containing only the one commodity at time of transit. Of the whole cargoes, 2,236,745 tons were from Atlantic to Pacific and 3,887,658 tons from Pacific to Atlantic. The shipments of commodities aggregating over 100,000 tons in shipload lots were as follows:

ATLANTIC TO PACIFIC

Commodity.	Tons.
Fuel oil	828,223
Coal and coke	651,844
Refined oils	355,494
Steel and iron	157,405

PACIFIC TO ATLANTIC

Nitrate	1,995,906
Flour	487,614
Cold storage products	347,479
Wheat	318,944
Lumber	205,172
Sugar	127,995

Nationalities of Vessels

Of the 2,814 commercial vessels using the Canal during 1920, the leading nationalities were as follows: The United States ships numbered 1,281, or 45.5 percent of the total; the British ships numbered 867, or 30.8 percent of the total; the Japanese, 122, or 5 percent; Norwegian, 111, or 3.9 percent. The numbers and tonnage of the ships, by nationalities, are summarized in this table:

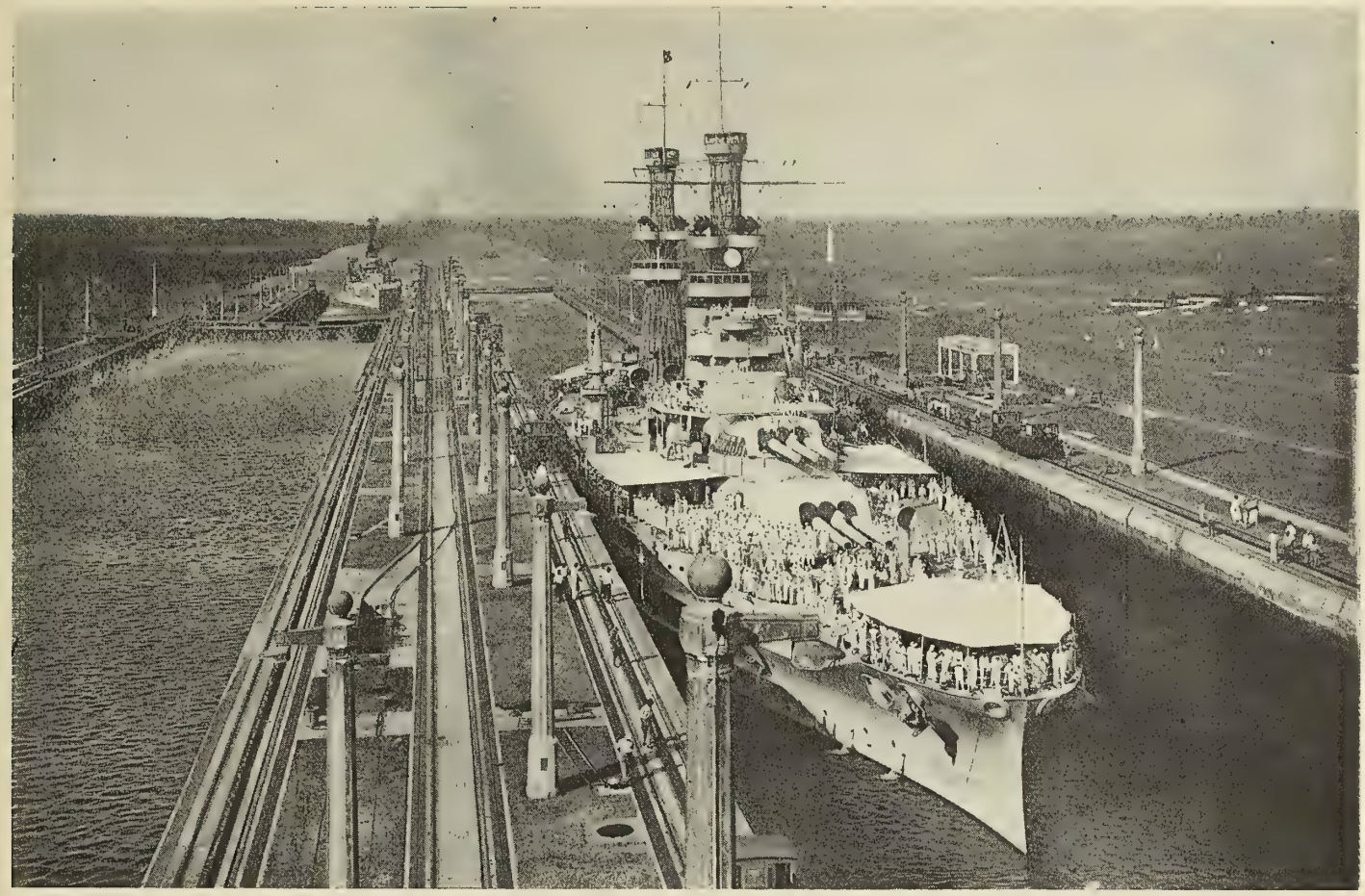
COMMERCIAL TRAFFIC THROUGH THE PANAMA CANAL FOR THE CALENDAR YEAR 1920, BY NATIONALITY OF VESSELS

Registry.	No. of ships.	Tonnage.				Tolls.	Tons of cargo.*
		U. S. equivalent	Panama Canal net.	Registered gross.	Registered net.		
Belgian	2	6,303	8,092	10,144	6,188	$7,886.25	12,700
Brazilian	1	5,436	6,294	6,692	4,126	6,795.00	8,916
British	867	2,707,826	3,333,676	4,242,357	2,649,963	3,357,357.55	3,305,681
Chilean	78	139,008	212,202	271,927	157,861	170,518.90	88,464
Chinese	4	10,564	12,008	16,[illegible]5	10,624	13,187.10	14,400
Colombian	1	84	85	96	57	105.00	27
Costa Rican	13	2,055	2,201	2,381	1,624	2,392.65	1,641
Cuban	1	578	702	1,050	577	722.50	1,200
Danish	30	92,255	110,432	131,297	84,662	114,035.15	158,110
Dutch	33	121,493	164,361	181,276	115,547	150,715.18	139,258
French	53	139,219	152,690	206,642	135,623	161,527.04	132,149
German	32	87,344	114,727	137,814	84,855	107,004.83	125,455
Italian	31	97,081	120,544	170,370	102,235	121,304.65	89,835
Japanese	122	480,197	545,665	723,476	466,303	583,643.93	764,206
Jugo-Slav	2	3,902	4,508	6,370	4,068	4,877.50	8,325
Mexican	2	2,169	2,638	2,559	1,659	1,899.36	.....
Norwegian	111	366,719	433,389	573,895	356,998	411,422.03	486,889
Panaman	8	1,382	1,370	1,568	1,340	1,489.90	872
Peruvian	72	115,603	187,621	288,515	153,110	143,129.05	119,462
Portuguese	2	8,838	9,002	11,210	7,056	10,802.40	10,775
Russian	1	4,740	5,14[illegible]	7,464	4,779	5,925.00	12,147
Swedish	18	51,743	75,454	78,668	57,918	63,511.25	92,893
Spanish	49	112,108	128,324	171,953	111,78[illegible]	130,615.33	153,467
United States	1,281	3,986,755	4,747,036	6,056,518	3,939,445	4,724,494.66	5,509,247
Totals	2,814	8,543,408	10,378,265	13,300,887	8,45[illegible],401	$10,295,362.21	11,236,119

*2,240 pounds to ton.

Record Traffic During January, 1921

"All previous records for traffic through the Canal were broken during the month of January, when 279 commercial



U. S. S. *Pennsylvania* in Middle Chamber of Gatun Locks at Panama Canal

and 79 noncommercial vessels transited the Canal. Of the above ships, 197 passed from the Atlantic to the Pacific and 161 from the Pacific to the Atlantic.

"The number of commercial vessels, tonnage, tolls, etc., as compared with previous high records, are as follows:

	January.	Previous high record.	Date.
Number of vessels	279	266	August, 1920.
United States equivalent tonnage	894,689	832,742	September, 1920.
Panama Canal net tonnage	1,094,323	1,027,918	December, 1920.
Registered gross tonnage	1,383,778	1,298,864	December, 1920.
Registered net tonnage	880,362	823,758	December, 1920.
Tolls levied	$1,095,857.46	$1,010,150.63	September, 1920.
Tons of cargo carried	1,177,052	1,076,539	December, 1920.

"Of the 79 noncommercial vessels, 60 were United States Navy ships, which were classified as follows: Battleships 9, cruiser 1, destroyers 19, supply vessels 10, mine sweepers 3, submarine chasers 4, submarines 7, submarine tender 1, repair ship 1, hospital ship 1, Navy tugs 3, Navy launch 1.

"In addition to the above 60 Navy vessels there were 7 vessels under control of the United States Shipping Board passing through the Canal with fuel for the Navy."

Notable Wartime Repair

In making up a heavy propeller shaft, four bronze sleeves were shrunk on the shaft. It was intended to have the sleeves close enough in series to admit of calking the joints. On cooling, however, it was found that the sleeves lacked approximately half an inch of butting—a distance too great for effective calking. The sleeves at either end of the series were of slightly greater diameter than the two intermediate sleeves, the former being designed to turn in bearings and the latter to serve merely as a protection for the steel shaft where it would otherwise be exposed directly to the corroding influence of salt water in the section between the two bearings.

To have brought the sleeves together by removing and reshrinking them, even if it could have been successfully accomplished, would have involved considerable difficulty and expense; and it seemed more than probable that such an attempt would have resulted in a repetition of the initial failure. For this reason it was decided to experiment with welding. It was not, however, deemed advisable to fill in the spaces by adding metal fused with the blowpipe while the sleeves were frozen to the shaft, as it seemed likely that the weld would pull apart on cooling. The problem, then, became one of applying preheat in a manner that would not result in disalinement of the shaft.

First a special preheating hood was prepared to admit of uniformly heating a single one of the four sleeves. Then one of the sleeves was expanded by preheating the area enclosed

Bronze Bearing and Protecting Sleeves Welded on Propeller Shaft

in the hood, when the preheated section was welded to the cold sleeve next in series. This process was then applied to the succeeding sections serially, in each instance heating a single sleeve and welding it to the cold sleeve adjoining.

Double Reduction Gears for Merchant Ships*

BY R. J. WALKER, C.B.E., AND S. S. COOK, B.A.

At the spring meetings of the Institution of Naval Architects last year a paper was read by Engineer-Commander Tostevin on "Experience and Practice in Mechanical Reduction Gears in Warships." Commander Tostevin in his paper dealt very fully with the development of gearing from its inception and the precautions necessary to ensure the successful running of these gears. The present paper is confined to the application of mechanical gearing to merchant ships, with particular reference to double reduction.

UP to the outbreak of war a total of over 260,000 horsepower of geared turbines for merchant service was built and under construction with single reduction gears. During the war and since the signing of the armistice about 750 ships, representing a total horsepower of over two millions, have been constructed in America alone, fitted with double reduction gearing, and in Great Britain and other countries the number of ships built and under construction is about 220, representing a total of about 1,150,000 horsepower.

In the initial stages of the development and application of double reduction gears in Great Britain certain troubles were experienced. In a few cases excessive wear of the teeth was found to have taken place either just after the full power trial or very early in the life of the vessel. This caused a certain amount of anxiety in the minds of some shipowners and engineers, and the position was somewhat aggravated by the fact that several double reduction gears in American ships had not come up to expectations.

Many theories were advanced as to the probable cause of the troubles referred to, among others the following: Too high a tooth pressure as compared with single reduction; defective material; inferior lubrication; and faulty workmanship in regard to cutting and alinement. As regards the first of these, there is no doubt that there was a very strong impression abroad that the tooth pressures adopted with double reduction gears were too high—that is, compared with single reduction gears. There was, however, no evidence to justify the conclusion that the pressures adopted with double reduction gears were higher than successful practice with single reduction would warrant. When comparing the proportions of gears a common use of the term "pressure per lineal inch of tooth surface" had been made by some engineers. Such a basis of comparison by itself had no real value. The load per inch of face should be judged in its relation to the diameter of the pinion employed.

Generally speaking, with conditions similar in other respects and with gears of the same ratio, the load per inch of face could be made to increase with the diameter of the pinion because of the difference in curvature of tooth surface. The radius of curvature of the surface of the teeth is practically in proportion to the diameter of the pinion. For large pinions above 10 inches diameter the practice of the Parsons Company is to allow the load per inch to increase only as the square root of the diameter. This empirical rule takes into account the width of line of contact on the assumption of a constant limit to the thickness of the effective portion of oil film. It is a more conservative view than has been taken by some makers, who allow the load per inch to increase directly with the diameter of pinion. For pinions less than 10 inches diameter the load is taken proportionately to the diameter of the pinion. The following figures represent the general average practice for service conditions in merchant ships. For pinions less than 10 inches and with the normal depth of tooth, the value of the constant $\frac{P}{d}$ lies between 60 and 75; for pinions above 10 inches diameter the value of the constant $P/\sqrt{d}$ lies between 180 and 220, unless lower values are specially requested.

In view of the troubles which occurred in the initial stages referred to previously, some shipowners had expressed a desire, in connection with new work, for a further margin of safety on past practice until more extended experience in actual service had been obtained.

As the result of further extended experience on service and theoretical investigations there is nothing to show that considerably higher loads could not be adopted than are represented by the above figures. Several vessels with double reduction gearing are now in service giving very satisfactory results. The steamship *Somerset* has been in service for over two years, the steamship *San Florentino* and steamship *San Fernando* over eighteen months, and three of the "N1" class standard ships—the *Danier, Andalusier* and *Aster*—for over twelve months. The loads and load constants for these vessels on service conditions are as follows:

Ship	Second Reduction Pinion Diameter, d	Load P in Pounds per Lineal Inch of Face	$P/\sqrt{d}$
S.S. *Somerset*	22.7	928	195
S.S. *San Florentino* S.S. *San Fernando*	19.334	932	212.5
S.S. *Danier* S.S. *Andalusier* S.S. *Aster*	13.58	880	238

The following particulars respecting double reduction gearing installed in a rolling mill at Calderbank, which has been in constant operation for ten years, may be of interest: Power transmitted, 750 horsepower; revolutions reduced from 2,000 for the turbines to 70 for the main wheel; load per inch of axial face, 1,150 pounds; diameter of pinion, 14.9 inches; and constant $P/\sqrt{d} = 298$.

The only cases of trouble in double reduction gears, with which the authors have been directly associated, arose in connection with two oil-carrying vessels, the *San Florentino* and *San Fernando,* in which the machinery is placed right aft. After the trials of the latter, indications were observed of excessive pressure at definite angular positions around the gear wheel. In these cases a peculiar condition had apparently arisen due to the variation in the propeller resistance as the blades cut through different parts of the wake, and the irregular tooth pressure which this caused was aggravated by the fact that at the full normal working speed the period of the blades passing the sternpost nearly synchronized with the period of the torsional vibration of the propeller and shaft in relation to the gear, thus greatly augmenting the pressure on the main gear wheel at certain positions on the periphery.

The frequency of torsional oscillation was estimated to be about 280 per minute, corresponding in the case of a four-bladed propeller to 70 revolutions per minute. The actual revolutions during the full speed trial were 65 to 67. This

* From a paper read at the sixty-second session of the Institution of Naval Architects, London, Eng., March 17, 1921.

question of synchronism is dealt with more fully later in the paper.

Experiments were taken in hand by Mr. Laing, of the Wallsend Slipway Company, in conjunction with the Parsons Company, in order to investigate the exceptional conditions which had arisen in connection with these two ships. The obvious remedy appeared to be to keep away from this critical period, and in the case of the S.S. *San Florentino* a three-bladed propeller was fitted instead of the existing four-bladed one, and this had the effect of diminishing the frequency of the blades passing the sternpost by about 30 percent. Concurrently new rims were fitted to the secondary gear wheels cut with a deeper tooth, so as to obtain increased tooth surface. It is understood that the gearing in this ship, after running 30,000 miles, is in splendid condition.

In the *San Fernando* temporary measures only were taken to obviate the synchronism to which the authors have alluded, by increasing the pitch of the propeller blades from 18 feet 6 inches to 20 feet 6 inches, and thus slightly reducing the revolutions, the gears installed in this vessel remaining as originally designed. An inspection of the gears after running 50,000 miles showed the teeth to be in excellent condition, no wear whatever having taken place other than the slight pitting or flaking which occurs in many gears in the initial running, and then ceases. This result was achieved with only the slight alteration in the pitch of the four-bladed propeller referred to.

Subsequently to this alteration records were taken on the S.S. *San Fernando* of the variation in torque by means of a Hopkinson-Thring torsion meter with scale boxes movable over an angular range of 150 degrees, readings being taken at intervals of 6 degrees.

These readings are shown in Fig. 1 at a propeller speed of 61.3 revolutions per minute. The figure for the torque has

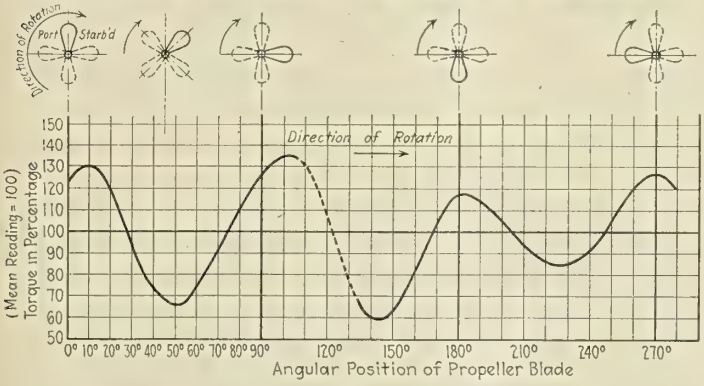


Fig. 1.—Variation of Torque, *San Fernando*

for convenience been reduced to a mean value of 100, and on this basis the maximum value obtained was 133.6 when one of the propeller blades was nearly vertical, and the minimum 67.9 with blades inclined at about 45 degrees. The length of shafting between propeller and gear was 35 feet.

Experiments were also made to determine the speed of the wake at various points of the screw disk by means of a model of the vessel with Pitot tubes attached to its stern. At a speed corresponding to 11 knots of the full-sized ship these experiments showed considerable variation in wake speeds, due apparently to the fulness of the after-end lines usual in this type of vessel. A judicious fining of the lower part of the cross-sections at the after end of the vessel, even at the expense of a probable slight increase in the length or dimensions of the vessel, would be advantageous and probably have the effect of considerably reducing the variation in wake, with a consequent improvement in propulsive efficiency. The values found for the ratio of $\frac{V - V_1}{V}$ (where V = speed of ship and V_1 = speed of wake water through screws) at various positions in the plane of the propeller are given in Fig. 2. The figures given on the diagram are not corrected for any difference in relative frictional resistance between the model and the full-sized ship.

Good materials and effective lubrication of the teeth are important. The authors are of the opinion, however, that the most important factors in the successful running of gears

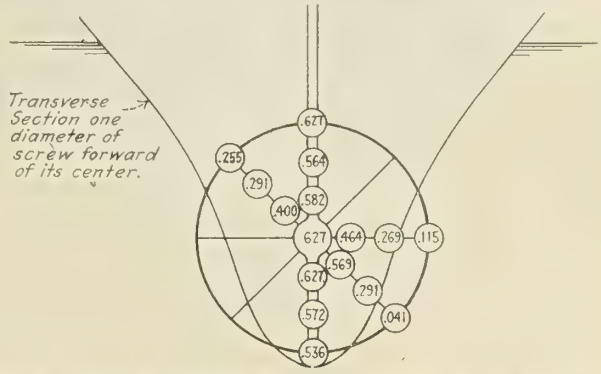


Fig. 2—Wake Distribution Obtained on Model of *San Fernando*

are accuracy in manufacture, which includes in particular the *cutting of the teeth* and *correct alinement*. These two points cannot be too strongly emphasized.

It is desirable that the machines for cutting gears should be periodically overhauled. It is also necessary that the truth of the machine should be checked at frequent intervals, especially after cutting heavy gear wheels.

The view has been frequently expressed that there is some vital difference between double reduction and single reduction gearing. The authors and their colleagues, after the investigations which have been made, see no reasons why double reduction gearing should be less satisfactory than single reduction. They can speak on this subject with greater confidence now that there are several double reduction sets in actual service and running very satisfactorily. In view, however, of the above impression, it is necessary carefully to analyse the details in which they differ.

Criticisms at one time or another have been devoted to the following features:

(1) The energy of the turbines and gearing.
(2) Flexibility of the shaft.
(3) The end movement of the secondary pinions.

As regards the first of these, the rotary energy of the turbine rotor is large because of its high angular and surface velocity. Whether the reduction be double or single, the energy of the turbine is, as a rule, greatly in excess of that of the gear wheels and propellers.

Supposing that there is a certain variation in the torque of the shaft, how does this affect the load upon the teeth? It is clear that the inertia of the gear wheel will absorb some of the shock. In the absence of elasticity in the rotor and pinion shafts and in the teeth themselves, the extent to which it does so is a matter of simple arithmetic. The shock has to be entirely absorbed by the increase or decrease of the combined rotary energy of turbines and gearing. The proportion of the shock which comes upon the teeth is in the ratio of the energy of the turbine rotor to the total of turbines and gearing. In consequence of the predominance of the energy of the turbine rotor, this is a large percentage in either case—in the neighborhood of 90 percent—and there can be very little difference between single and double reduction in this respect.

A main propeller shaft of about 15 inches diameter does not at first glance appear to be a very flexible object. This is, however, a question of degree. The twist of the shaft at full load over so short a length as 2 or 3 feet is now commonly

used to measure the horsepower transmitted. Over a considerable length the twist is quite appreciable. Thus for a shaft of 15 inches, transmitting, say, 3,000 horsepower at 100 revolutions per minute, the angular twist is about 2 degrees for every 100 feet of length. This is equivalent to a displacement of 2 inches at the periphery of a 9-foot propeller or of a gear wheel of that diameter. A flexibility of this order is necessary to absorb the periodic variation of propeller resistance of a four-bladed propeller. To provide this flexibility in any other way is almost impracticable. It cannot be provided in the intermediate shaft, for to do so would demand that the angular twist of that shaft at full load should be some 10 or 12 degrees, viz., the 2 degrees mentioned above multiplied by the ratio of the diameters of secondary wheel and pinion. It will be seen that as regards any variation at the teeth of the gear, the main shaft is by far the most flexible part of the installation. The flexibility of the pinion shaft, along with the structural flexibility of gear case and teeth, may, however, have some value in reducing fluctuations of higher frequency, such as might arise from irregularities in the teeth. If then there is any difference between a single and a double reduction in this respect, it will be to the advantage of the latter.

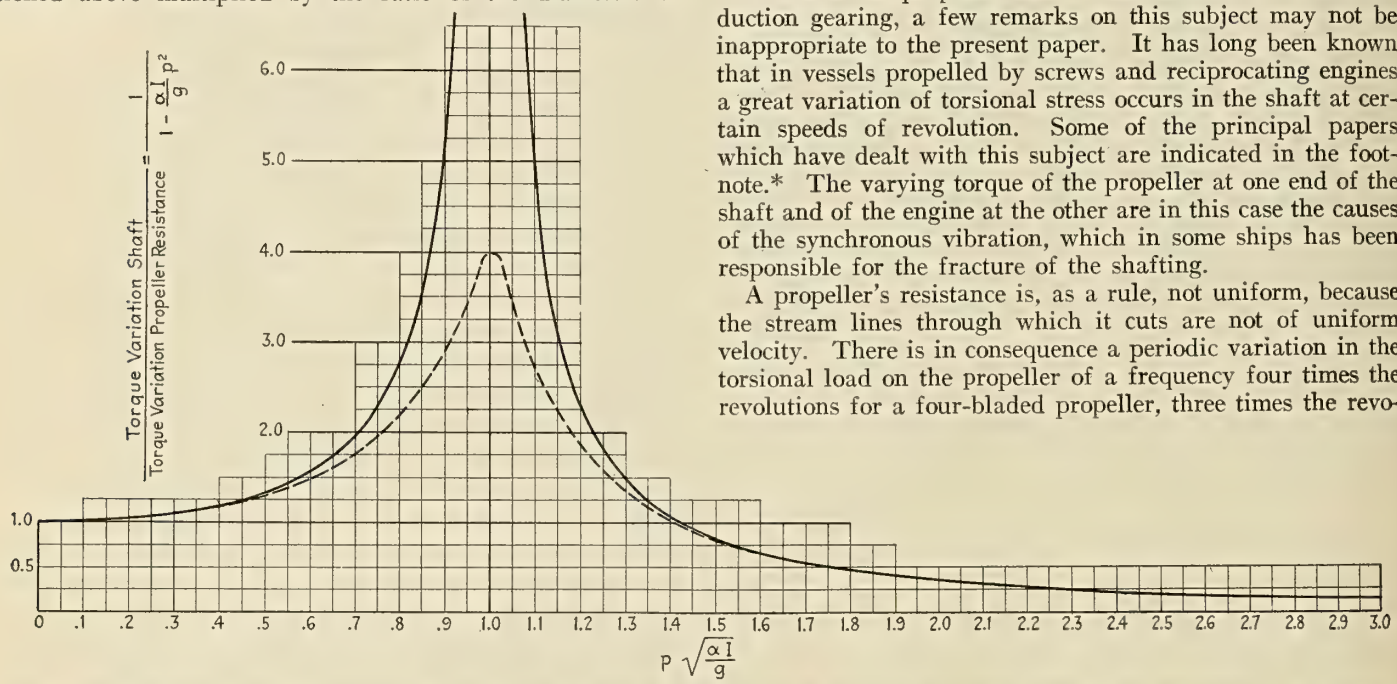


Fig. 3.—Curve Showing Torque Variation at Gear Wheel End of Propeller Shaft as Affected by Flexibility of Shaft and Inertia of Propeller

Another feature has been referred to, viz., the end movement of the secondary shaft. Those who have ever measured the amount of end movement of a pinion will agree that a movement of 1/100 inch would be a very conspicuous amount. Let it be supposed, however, that the movement is double this—that is to say, 1/100 inch in each direction from the mean position, and synchronizing with the revolutions of the wheel. From this amplitude and period it is simple enough to calculate the maximum acceleration. At 100 revolutions per minute it will be 1/350th of the gravity acceleration, so that the force on the teeth in an endwise direction arising from this motion would be equal to 1/350th of the total weight of the secondary shaft, or, in other words, a force of a few pounds only. In comparison with the total end force on the teeth this is insignificant.

Another point which received careful investigation at the time of the introduction of double reduction gearing was the equilibrium of the intermediate shaft. The resultant force on the primary teeth is not equal in amount to, nor in general in the same direction as, that on the secondary teeth. Where these forces are in an upward direction there will be a certain speed at which the intermediate shaft will rise in its bearings, and unless both ends rise together it would go out of alinement. In most cases this difficulty is overcome by placing the primary wheels between the halves of the secondary pinion teeth, so that the loads on the teeth are symetrically disposed along the intermediate shaft. In other cases it is desirable to arrange matters so that the shaft rises at a comparatively low speed, so that at full loads it is firmly pressed against the top side of the bearings and again in alinement. It is necessary to study carefully the direction of the resultant forces on the bearings of this shaft under various loads, so that the oil grooves may be placed correctly.

Although the possibility of the occurrence of torsional vibration of the propeller shaft is not confined to double reduction gearing, a few remarks on this subject may not be inappropriate to the present paper. It has long been known that in vessels propelled by screws and reciprocating engines a great variation of torsional stress occurs in the shaft at certain speeds of revolution. Some of the principal papers which have dealt with this subject are indicated in the footnote.* The varying torque of the propeller at one end of the shaft and of the engine at the other are in this case the causes of the synchronous vibration, which in some ships has been responsible for the fracture of the shafting.

A propeller's resistance is, as a rule, not uniform, because the stream lines through which it cuts are not of uniform velocity. There is in consequence a periodic variation in the torsional load on the propeller of a frequency four times the revolutions for a four-bladed propeller, three times the revolutions for a three-bladed propeller, and so on. The shaft, however, is flexible, as we have seen, and the changes in the torque transmitted through the shaft will be somewhat different from the changes in the propeller resistance. At one end of this flexible shaft is a propeller possessing a certain amount of inertia. At the other end is a gear wheel in contact with other gear wheels attached to the turbine rotor. On account of the high revolutions of the turbine the rotary energy of the turbine and gear wheels is many times greater than that of the propeller, and for the sake of simplicity and clearness of conception this end may be considered as having infinite inertia or a constant angular velocity. There is then a flexible shaft, one end fixed or moving with constant angular velocity, and to the other end attached a mass of known inertia. The theory of the motion of such a system is now pretty well known. In the absence of damping it can vibrate freely as a torsional pendulum with a frequency which is determined by the flexibility of the shaft and the moment of inertia of the propeller. When the variation of the propeller resistance synchronizes with this natural frequency a state of

* Frahm, "Recent Investigations Concerning Dynamical Action in Shafting of Marine Engines, with Special Reference to Synchronous Torsional Vibration," Journal American Society of Naval Engineers, August, 1902; Journal German Society of Engineers, 1902.

Gumbel, "Torsional Vibrations of Shafts," Transactions Institution of Naval Architects, 1902, 1912.

Lanchester, "Engine Balancing," Proceedings of Institution of Automobile Engineers, March, 1914.

Jansen and Richardson, "Investigation of Shafting Failures and Engine Vibration on Vessels of the *Louisiana* Class," Journal of the American Society of Naval Engineers, February, 1917.

J. Frith and E. H. Lamb, "The Breaking of Shafts in Direct Coupled Units, Due to Oscillations Set Up at Critical Speeds," Journal of Institute of Electrical Engineers, March, 1902.

forced oscillation is set up, and the torque in the shaft, and consequently the pressure on the gear wheel teeth, may be subject to very considerable fluctuations.

It is not sufficient, however, to calculate this natural frequency and avoid synchronism between it and the propeller impulses, because large periodic forces may be induced in the shaft for a considerable range of speed on either side of synchronism. It is necessary to have a complete determination of the forces set up in the flexible shaft under a periodic variation of the propeller resistance of any frequency. With this done it is then possible to see to what degree the shock on the propeller is carried through to the gear wheel teeth, or, in other words, to what extent it is smoothed out by the elasticity of the shaft and under what conditions it is aggravated by this elasticity.

Assume, then, first of all, the simple system consisting of a shaft fixed at one end and carrying at the other end a disk of known inertia, beyond which is applied a periodic impulse, $P \sin p\,t$, of frequency $p/2\pi$. In such a system, if a be the flexibility of the shaft measured by the ratio $\frac{\text{twist}}{\text{torque}}$ and I the moment of inertia of the disk, or propeller, at its end, the varying torque in the shaft will be expressed by the formula

$$\frac{P \sin p\,t}{1 - \frac{aI}{g} p^2}.$$

If there were no damping effect, this would become infinitely great when $p = \sqrt{\frac{g}{aI}}$, and this value of p corresponds to the frequency of natural vibration. Thus when $p = \sqrt{\frac{g}{aI}}$ there is a synchronism between the applied impulse and the natural vibration, and only damping prevents the vibrations from attaining amplitudes sufficient to break the shaft. One method of investigating the subject, therefore, is to estimate this critical speed and compare it with the frequency of the applied disturbance. The better way, however, is to use the above formula to obtain an exact estimate of the variation at any speed. This formula will show the extent to which the impulses are felt at the end of the flexible shaft for all values of their period on either side of the synchronous speed.

Now, the actual case of a propeller shaft driven by gearing (if we neglect the weight of the shaft and regard the energy of rotation of the turbines and gearing as being so large that this end may be considered to have an invariable speed) is precisely similar to such a system.

$P \sin p\,t$ representing the variation in propeller resistance above and below its normal value, occurring $\frac{p}{2\pi}$ times every second, the variation in the value of the turning moment of the forces on the gear wheel teeth above and below its normal value will be given by

$$\frac{P \sin p\,t}{1 - \frac{aI}{g} p^2},$$

where

a = flexibility of the shaft = $\frac{\text{twist}}{\text{torque}}$,

I = moment of inertia of the propeller.*

The diagram (Fig. 3) shows the changing value of the maximum torque variation as the flexibility of the shaft is increased. With a perfectly stiff shaft the variation in the propeller resistance is transmitted along the shaft undiminished. As the flexibility is increased the effect in the shaft first increases until the point of synchronism is reached and then diminishes. When the flexibility has increased to double that which gives synchronism the torque variation has again fallen to a value equal to that of the propeller resistance. For further increase of flexibility it continues to diminish until for large values it practically disappears, leaving the torque at the end of the shaft practically undisturbed by the impulses on the propeller blades.

In the neighborhood of synchronism the variation is considerably damped owing to the resistance of the water to change of propeller speed, so that the real curve would be somewhat as shown by the dotted line.

With the engines amidships there is, as a rule, no difficulty in obtaining sufficient flexibility to give a value of $\frac{aI}{g} p^2$ in the neighborhood of 7 or 8, in which case, as will be seen from the diagram, the variation of torque is almost annulled. But where the engines are placed aft with a shaft only between 30 and 40 feet in length, it will usually be found that the value of $\frac{aI}{g} p^2$ is less than 1.0, and it may be necessary to increase the diameter of the shaft to avoid too large a variation factor.

* This can be easily proved (without recourse to differential equations) by denoting the torque in the shaft by $L \sin p\,t$. The angular displacement of the propeller end of the shaft will be $-\,a\,L \sin p\,t$ on account of its flexibility. The angular acceleration of the propeller will therefore be $+\,p^2\,a\,L \sin p\,t$, and the torque required to produce it $+\,p^2 \frac{aI}{g} L \sin p\,t$. The torque of the shaft must therefore be greater by this amount than the torque of propeller resistance, which is therefore equal to $\left(1 - \frac{aI}{g} p^2\right) L \sin p\,t$, or $\left(1 - \frac{aI}{g} p^2\right)$ times the torque in the shaft, having the same frequency and phase. The frequency is $\frac{p}{2\pi}$ (since when t is increased by $\frac{2\pi}{p}$ the value of $\sin p\,t$ is repeated). The synchronous frequency is therefore $\frac{I}{2\pi}\sqrt{\frac{g}{aI}}$.

Shipbuilding in Porto Rico

BY A. H. JOHNSEN

A 1,000-TON steel coal barge, 152 feet long overall, 124 feet long on the waterline, 36 feet beam, and 11 feet load draft, is under construction near San Juan, P. R., for the Porto Rico Coal Company. The barge is not only capable of carrying 1,000 tons of coal, but provision for 400 tons of water will be made later, if desired.

On each side running lengthwise is a sloping bulkhead, and at the bottom a bucket type of conveyor will carry the coal to a tower located at the end of the barge. This tower reaches 68 feet above the deck and is so arranged that both sides of a vessel may be bunkered simultaneously.

The coaling machine, of the elevator type, is a combination between the Link-Belt and the De Mayo types, and is so arranged that it will deliver 250 to 300 tons of coal an hour.

The building of this barge in Porto Rico is quite a problem, as all the steel, plant equipment, lumber, etc., was brought from the United States. The vessel is being built under Lloyd's rules and specifications. Snare and Triest Company, of New York, has the contract at a cost of about $132,000.

Problem of the Hull and Its Screw Propeller—II*

Derivation of Design Curves for the Screw Propeller—Computation for Basic Condition of Propeller—Problems Illustrating Analysis of Propeller

BY REAR-ADMIRAL C. W. DYSON, U. S. N.

THE vessels which are selected to be used must all have propellers having the same radial distribution of projected area but of several different projected area ratios. The vessels selected by the author were of types 1 and 3, but of different block coefficients, and ranged from a *S.B.C.* of .375 to .60, from a destroyer to a dreadnought, while the projected area ratios, measured outside of a circle of two-tenths the diameters of the propellers, varied from .6 to .328.

The blades were oval with the widest part of the projection at two-thirds the radius from the center, while the blade peripheries outside the widest part, measured on the arc, were well rounded.

The ships at trial were just out of dry dock, thoroughly cleaned and painted, and were run over the measured mile in good weather. Each point of the trial curves was obtained by at least three runs at the same or approximately the same revolutions, two runs in one direction and one in the opposite. The highest point of the performance curves was obtained by five runs.

The propellers of all the ships were of manganese bronze machined to a true pitch and to the desired blade sections, which were the same type for all the propellers and highly polished.

The trials were run by competent and experienced men, while the data were taken and computed by trained observers and engineers. There was every reason to believe that what were collected were as reliable as could ever be obtained under actual ship conditions.

Derivation of Design Curves

Taking the derived data and from these obtaining values of pounds indicated thrust per square inch of disk area ($I.T._D$) of the propeller and corresponding pounds propulsive thrust per square inch of projected area ($P.T._p$), a series of curves were plotted with $I.T._D$ as abscissas and $P.T._p$ as ordinates and intermediate curves for intermediate projected area ratios were interpolated.

Curves of corresponding tip speeds in feet per minute ($T.S.$) and of propulsive coefficient ($P.C.$) were also laid down, as were also the curves of apparent slip (S).

At one point on each of the established curves of $I.T._D$ — $P.T._p$ a decided change in conditions was found to occur, the curve either taking a sudden rapid rise or beginning to fall rapidly.

The values of these points in $I.T._D$, $T.S.$, $P.C.$ and S were taken and plotted on values of $P.A. \div D.A.$ (projected area ratio) as abscissas and the equations to the curves obtained when possible, that for $I.T._D$ being:

$$I.T._D = 28.54\left(\frac{P.A.}{D.A.}\right)^{1.7}$$

while that for $T.S.$ is:

$$T.S. = 38.148\left(\frac{P.A.}{D.A.}\right)^{.8365 - .2\left(\frac{P.A.}{D.A.}\right)}$$

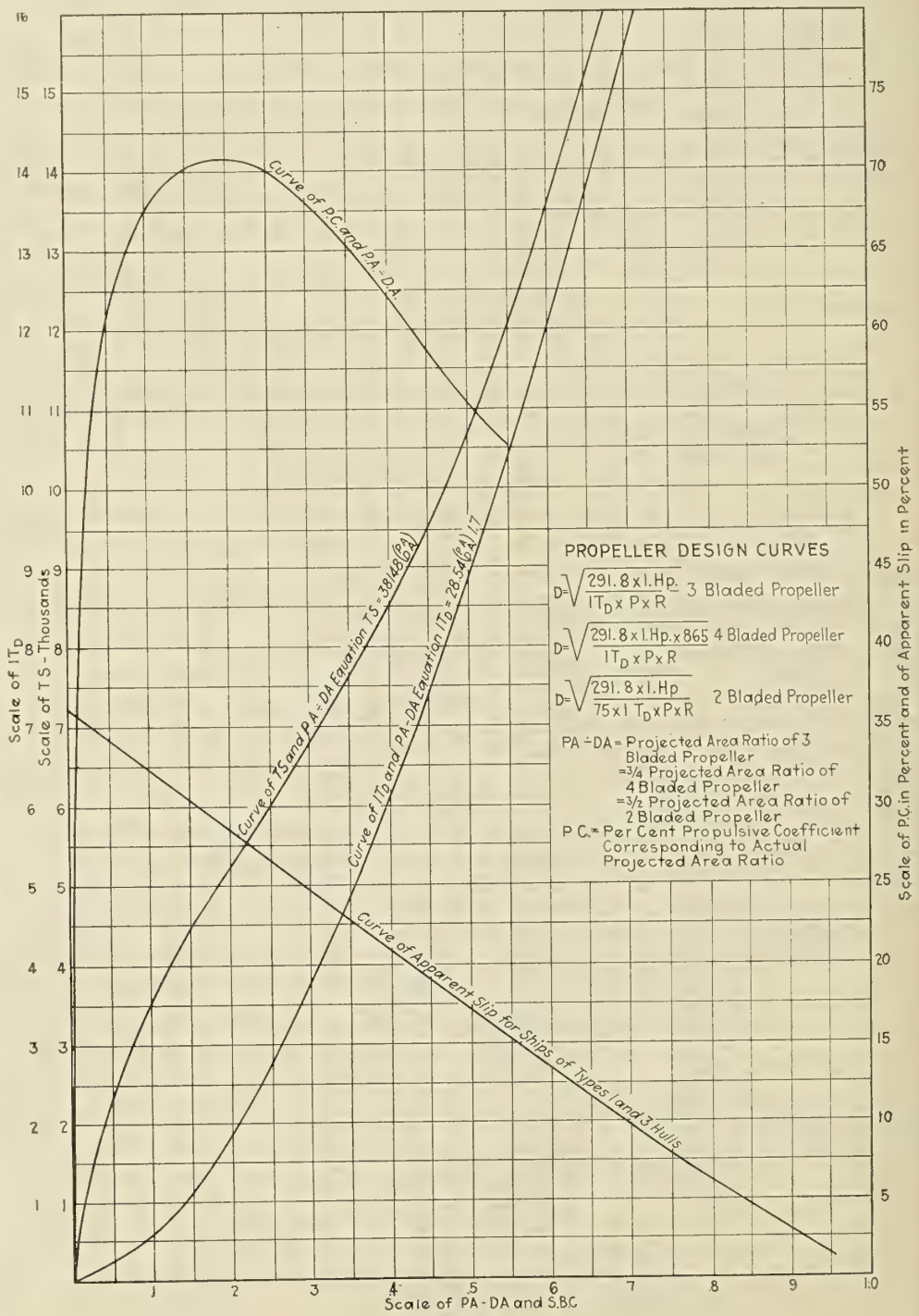


Fig. 5

* Paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1920.

Equations to the curves of *P.C.* and of *S* could not be obtained.

These curves are all shown on Fig. 5 and the conditions covered by them are denoted basic conditions and are constant, with the exception of the *S* curve, which, it will be noted, is based on *S.B.C.* as abscissas and not on *P.A.* ÷ *D.A.* In other words, each standard *S.B.C.* has its constant standard basic slip.

This curve of *S* is again shown on Fig. 6, but is there based on values of 2 × length of after body of the ship ÷ the draft, which brings in the final correction for hull form already mentioned.

Correction of *S* for Varying Values of *2L.A.B.* ÷ *H*

On Fig. 6 is shown a curved marked Slips for *S.B.C.* on *X* — *W*, Type 1 and 3 Hulls. This curve is in reality the same as the curve of *S* shown on Fig. 5, but in the case of Fig. 6 it is erected on abscissa values of *2L.A.B.* ÷ *H* instead of on *S.B.C.* and the *S.B.C.* values are marked on it at the standard values of *2L.A.B.* ÷ *H* as determined from Fig. 1.

Experience has demonstrated that as the lengths of after bodies of ships increase or decrease from the standard the basic values of *S* decrease or increase, and in decreasing or increasing follow a general law which may be expressed by the following equation:

$$A\ (1 - S)^a = \frac{2L.A.B.}{H},$$

where *A* is the length of after body ÷ *H* at which the basic apparent slip becomes zero, while the exponent *a* depends for its value upon *A*. The lower scale of abscissa is the scale of *A* upon which the curve of the exponent *a* is erected. The curves developed from the equation for coincident values of *A* and *a* are erected on values of *2L.A.B.* ÷ *H* as abscissas, the scale being that given on the upper scale of abscissas, Fig. 6, while the ordinates are values of basic apparent slip *S*.

The curves are direction curves according to which *S* varies as the ratio *2L.A.B.* ÷ *H* varies from standard. Thus, suppose the *S.B.C.* of the vessel be .575. By examination of Fig. 6 it is seen that the curve marked *A* = 22.5 crosses the line of standard *S* at *S.B.C.* = .575 and *2L.A.B.* ÷ *H* = 16.3. Now suppose the ratio *2L.A.B.* ÷ *H* for the vessel in question be 17½. The curve *A* = 22.5 is seen to cross the ordinate of 17½ = *2L.A.B.* ÷ *H* at .113, which is the value of *S* to use in determining the basic condition of the vessel's propellers.

Computation for Basic Condition of Propeller

To illustrate the method of determining the basic condition of a propeller, let an example be taken, as follows:

Suppose the corrected *S.B.C.* of the vessel be .575; the ratio *2L.A.B.* ÷ *H* be 17.5; the propeller blades of standard form and three-bladed.

Let diameter = *D* = 16 feet; pitch = *P* = 18 feet; projected area ratio = *P.A.* ÷ *D.A.* = .34. Then from Fig. 5 we obtain the following data:

1. Tip speed for *P.A.* ÷ *D.A.* = .34 = 7,480 feet, from which, since

pitch × revolutions = $P \times R = \dfrac{T.S. \times P}{\pi D}$,

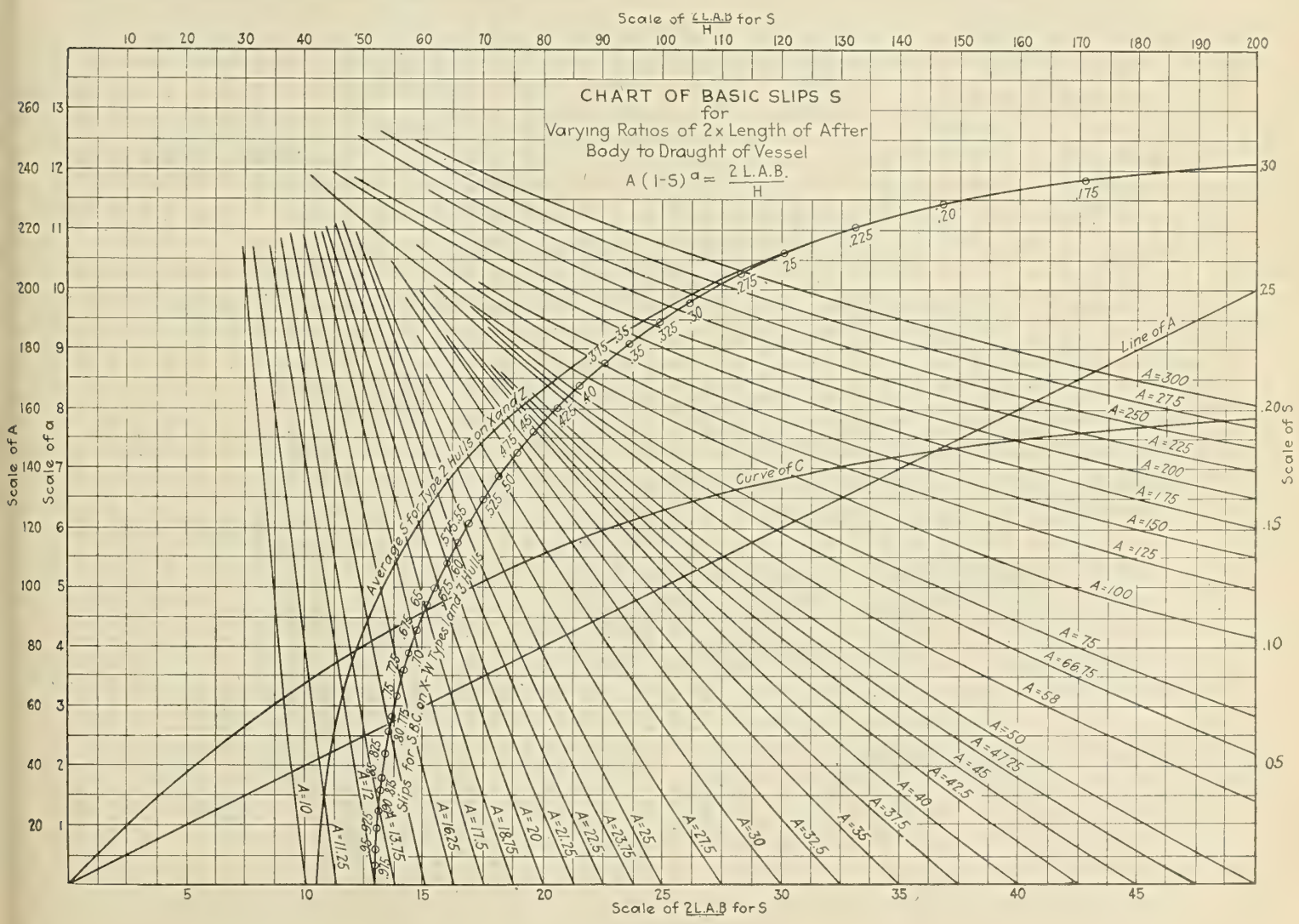


Fig. 6

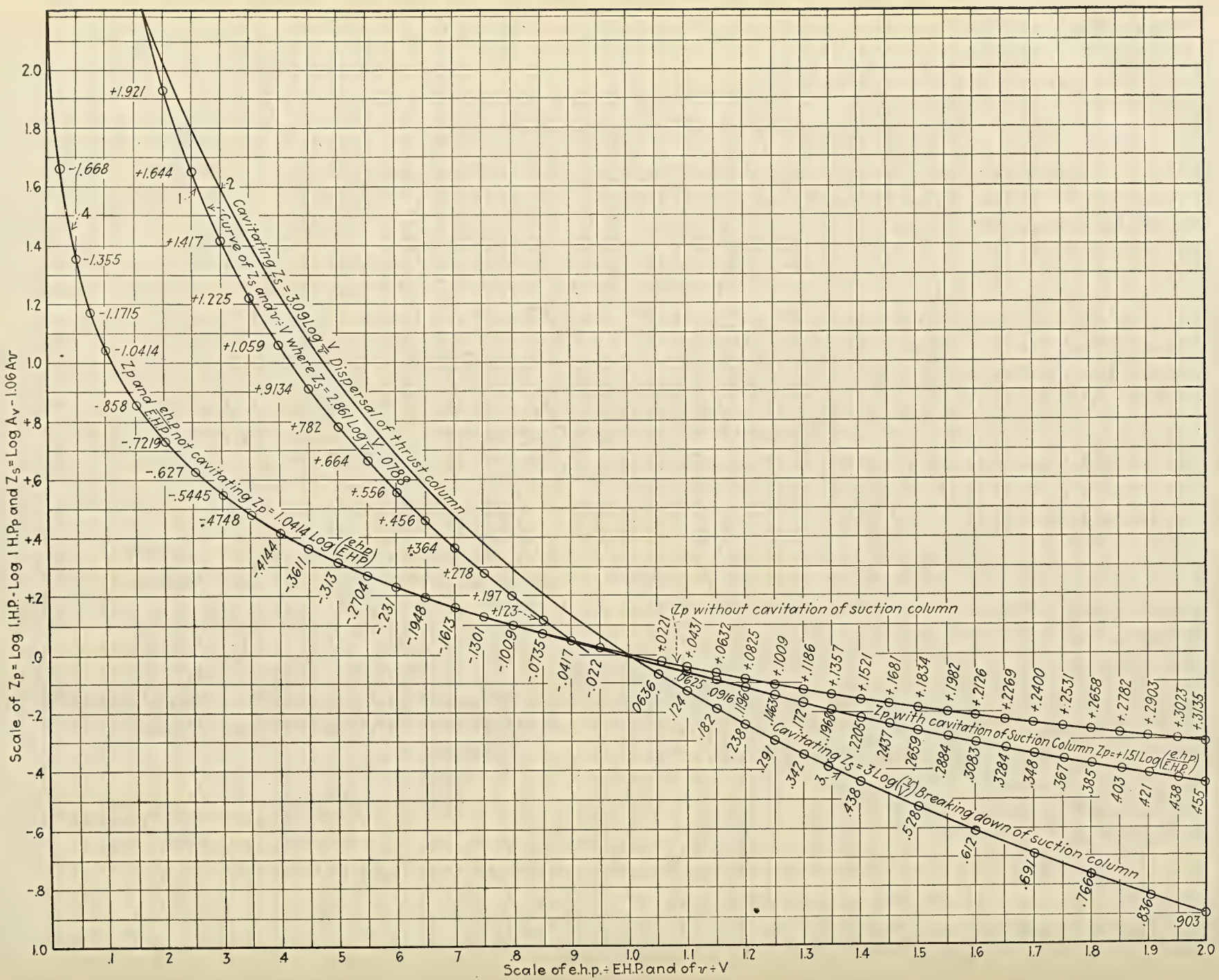

Scale of Zp = Log I.H.P. - Log I H.Pp and Zs = Log Av - 1.06 Avr
Scale of e.h.p. ÷ E.H.P. and of v ÷ V
Cavitating Zs = 3.09 Log v/V Dispersal of thrust column
Curve of Zs and v ÷ V where Zs = 2.861 Log v/V - .0788
Zp and e.h.p/E.H.P not cavitating Zp = 1.0414 Log (e.h.p/E.H.P)
Zp without cavitation of suction column
Zp with cavitation of Suction Column Zp = +1.51 Log (e.h.p/E.H.P)
Cavitating Zs = 3 Log (v/V) Breaking down of suction column

Fig. 7

$$\text{basic speed} = V = \frac{P \times T.S.\,(1 - S)}{\pi D \times 101.33} = \frac{18 \times 7{,}480 \times .887}{\pi \times 16 \times 101.33} = 23.45 \text{ knots.}$$

2. Indicated thrust per square inch of disk area $= I.T._D = 4.7$ for $P.A. \div D.A. = .34$, then basic indicated horsepower for a three-bladed propeller =

$$I.H.P. = \frac{P \times R \times I.T._D \times D^2}{291.8} = \frac{T.S. \times P \times I.T._D \times D}{\pi \times 291.8} = \frac{7{,}480 \times 18 \times 4.7 \times 16}{\pi \times 291.8} = 11{,}045,$$

and assuming that the shaft horsepower equals 92 percent of the indicated in well built and adjusted engines, a figure which experience demonstrates to be nearly correct, basic shaft horsepower $= S.H.P. = .92 \times I.H.P. = 11{,}045 \times .92 = 10{,}161.4$.

3. The propulsive coefficient for a projected area ratio of .34 is seen from Fig. 5 to be $P.C. = .667$. Therefore the basic effective horsepower $= E.H.P. = I.H.P. \times P.C. = 11{,}045 \times .667 = 7{,}367$.

Variation of the Above for Four Blades and for Two Blades

Suppose the propeller should have four blades with a total projected area ratio $= .453$ or a two-bladed one with a projected area ratio $= .227$, then:

Blades	4	2
Total $P.A. \div D.A. =$	.453	.227
Total $P.A. \div D.A. =$	.34	.34

that is, the basic $P.A. \div D.A.$ equals ¾ total for the four blades and equals 3/2 total for the two blades.

The values of $T.S.$ and $I.T._D$ are those pertaining to the basic $P.A. \div D.A.$, while the propulsive coefficients which are dependent upon the total area ratio will be those corresponding to the total projected area ratios.

The formulas for basic indicated horsepower become for four blades:

$$I.H.P. = \frac{T.S. \times P \times I.T._D \times D}{.865 \times \pi \times 291.8} = \frac{7{,}480 \times 18 \times 4.7 \times 16}{\pi \times 252.41} = 12{,}768.$$

For two blades:

$$I.H.P. = \frac{T.S. \times P \times I.T._D \times D \times .75}{\pi \times 291.8} = \frac{7{,}480 \times 18 \times 4.7 \times 16}{\pi \times 389.1} = 8{,}283.$$

The basic effective horsepowers now become:

Four blades: $E.H.P. = 12{,}768 \times .568 = 7{,}252$.
Two blades: $E.H.P. = 8{,}283 \times .712 = 5{,}898$.

Should the blades be of other than standard distribution of projected area, other corrections occur which the limits of this paper will not allow of discussion.

Conditions Other Than Basic (Fig. 7, Curve 4)

Usually the performance of a vessel and its propeller will be very remote from the basic conditions of the propeller. In such cases it is necessary to have a ready means of converting from basic to actual conditions, and such means, so far as power is concerned, are provided as follows:

Let $e.h.p.$ be the effective horsepower required by a given vessel for a speed v, then

$$\frac{e.h.p.}{E.H.P.} = \text{fraction of basic load and } \frac{v}{V} = \text{fraction of basic speed.}$$

Taking a large number of vessels having hulls of such form and propellers so located that the value of the power augment K will be unity and from the curves of performance of each vessel obtaining the indicated horsepower required to deliver fractional loads with the speeds v at which these fractional loads were required and denoting this $I.H.P.$ by $I.H.P._p$ the equation for $I.H.P._p$ will be:

$$I.H.P._p = I.H.P. \times \left(\frac{v}{V}\right)^w$$

in which the factor $\left(\frac{v}{V}\right)^w$ is constant for any given value of $\frac{e.h.p.}{E.H.P.}$.

This equation may be expressed thus:

$$\text{Log } I.H.P._p = \log I.H.P. + w\,(\log v - \log V),$$

which, by transposing, becomes:

$$w\,(\log V - \log v) = \log I.H.P. - \log I.H.P._p.$$

Now represent this value $w\,(\log V - \log v)$ by the symbol Z_p, and after establishing several values of it at corresponding load fractions determine the equation to the curve passing through these points and the basic point where $\frac{e.h.p.}{E.H.P.}$ and $\frac{v}{V}$ both equal unity.

This equation will be:

$$Z_p = 1.0414 - 1.0414 \log\left(\frac{10\,e.h.p.}{E.H.P.}\right);$$

or, to simplify it,

$$Z_p = 1.0414 \log\left(\frac{E.H.P.}{e.h.p.}\right)$$

for values of $\frac{e.h.p.}{E.H.P.}$ less than unity, and

$$Z_p = 1.0414 \log\left(\frac{e.h.p.}{E.H.P.}\right)$$

for values of $\frac{e.h.p.}{E.H.P.}$ greater than unity; these values are subtractive from log $I.H.P.$ in the first case and additive in the second, so that for values of

$$\frac{e.h.p.}{E.H.P.} < 1,\ \log I.H.P._p = \log I.H.P. - Z_p$$

$$\frac{e.h.p.}{E.H.P.} > 1,\ \log I.H.P._p = \log I.H.P. + Z_p.$$

Should the efficiency of the combined hull and propeller be such that the value of the power augment factor K is greater than unity, then, denoting the total power by $I.H.P._d$,

$$I.H.P._d = K \times I.H.P._p = \frac{K \times I.H.P.}{10^{Z_p}},$$

or

$$\text{Log } I.H.P._d = \log I.H.P. + \log K \mp Z_p.$$

These equations neglect all correction for effects of cavitation, which will be discussed further on.

Problems Illustrating Analysis of Propeller

In order to illustrate all that has been treated in the foregoing, two problems are here given, the first being the series of vessels used by Commander McEntee in his article on the "Propulsive Efficiency of Single Screw Cargo Ships" which was read before the Society of Naval Architects and Marine Engineers at its 1919 annual meeting.

It must be remembered, however, that in Commander McEntee's vessels the ships were not evenly balanced in their lines, the effect of shifting the middle body aft having its greatest effect on that vessel having the resultant shortest

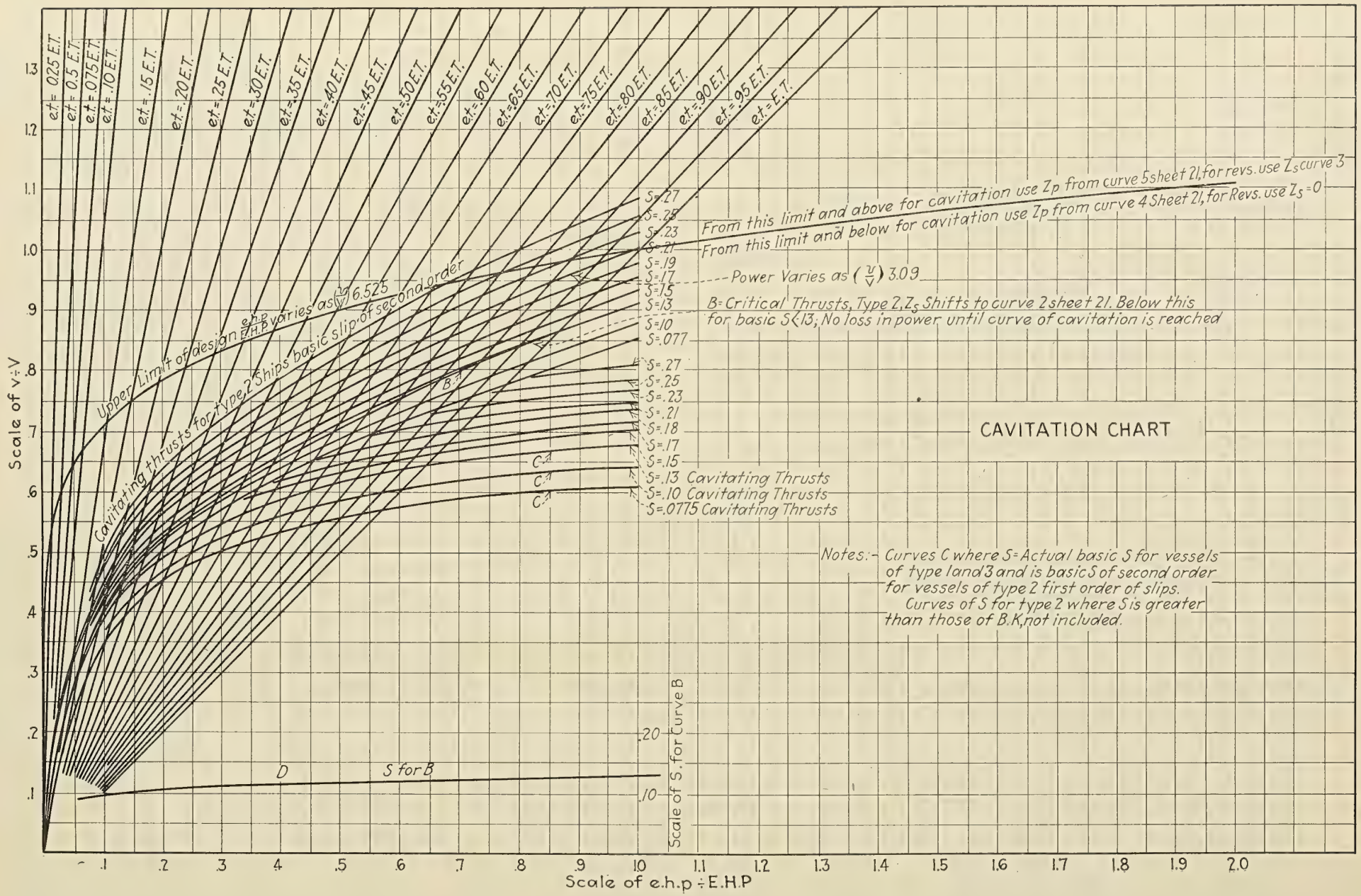

CAVITATION CHART
e.t.=.025 E.T.
e.t.=.05 E.T.
e.t.=.075 E.T.
e.t.=.10 E.T.
e.t.=.15 E.T.
e.t.=.20 E.T.
e.t.=.25 E.T.
e.t.=.30 E.T.
e.t.=.35 E.T.
e.t.=.40 E.T.
e.t.=.45 E.T.
e.t.=.50 E.T.
e.t.=.55 E.T.
e.t.=.60 E.T.
e.t.=.65 E.T.
e.t.=.70 E.T.
e.t.=.75 E.T.
e.t.=.80 E.T.
e.t.=.85 E.T.
e.t.=.90 E.T.
e.t.=.95 E.T.
e.t.=E.T.
From this limit and above for cavitation use Zp from curve 5 sheet 21, for revs. use Zs curve 3
From this limit and below for cavitation use Zp from curve 4 Sheet 21, for Revs. use Zs=0
Power Varies as (v/V) 3.09
B=Critical Thrusts, Type 2, Zs Shifts to curve 2 sheet 21. Below this for basic S<.13; No loss in power until curve of cavitation is reached
Upper Limit of design e.h.p/E.H.P varies as (v/V) 6.525
Cavitating thrusts for type 2 Ships basic slip of second order
S=.27
S=.25
S=.23
S=.21
S=.19
S=.17
S=.15
S=.13
S=.10
S=.077
B
C
S=.27
S=.25
S=.23
S=.21
S=.18
S=.17
S=.15
S=.13 Cavitating Thrusts
S=.10 Cavitating Thrusts
S=.0775 Cavitating Thrusts
Notes:- Curves C where S=Actual basic S for vessels of type 1 and 3 and is basic S of second order for vessels of type 2 first order of slips.
Curves of S for type 2 where S is greater than those of B.K, not included.
D
S for B
Scale of S. for Curve B
Scale of v÷V
Scale of e.h.p÷E.H.P

Fig. 8

PROBLEM 1.—VESSELS OF TYPE 2, SINGLE SCREW

$L.B.P. = 400'$	$\frac{2L.A.B.}{H} =$	$11'.9$	$11'.4$	$10'.88$	$10'.37$	$9'.86$
$B = 57'.3$						
$H = 26'$	Nom. $B.C.$	.7242	.7438	.7634	.7830	.8026
$\frac{B}{L.B.P.} = .1432$	$K.B.C.$	.758	.773	.786	.801	.815
	K	1.175	1.2	1.23	1.27	1.31
$\frac{H}{B} = .454$	$S.B.C.$	.7925	.813	.825	.84	.855
	S	.14	.155	.17	.195	.2175
$D = 16'.583$						
$P = 14'.75$						
$\frac{P.A.}{D.A.} = .267$						
Blades = 3						
$T.S. = 6{,}230$						
$P \times R = 1{,}764$						
$1 - S = .86$	.845	.83	.805	.7825		
$V = 14.97$	14.71	14.45	14.01	13.8		
$I.T.D = 3.09$						
$I.H.P. = 5{,}137$						
$P.C. = .696$						
$E.H.P. = 3{,}575$						
$S.H.P. = 4{,}726$						
$v = 11$	11	11	11	11		
$v \div V = .7348$	.7479	.7614	.785	.8076		
$e.h.p. = 1{,}160$	1,200	1,260	1,370	1,580		
$e.h.p. \div E.H.P. = .3244$	.3357	.3525	.3832	.442		
Z_p (Fig. 6) = —.51	—.492	—.47	—.432	—.382		
$K = 1.175$	1.2	1.23	1.27	1.31		
$S.H.P._a = 1{,}716$	1,827	1,970	2,220	2,569		
Act. Power = 1,750	1,850	1,980	2,200	2,700		

after body. As the curves on Fig. 1 for estimation of $S.B.C.$ are based on forward and after bodies of equal length the result may be a slight under estimate of $S.B.C.$ and of K in the case of one or more of the vessels of the fuller nominal block coefficients.

By comparison of the estimated and actual powers it will be seen that the only difference of serious amount is with the vessel having the heaviest nominal block coefficient, as was to be expected due to the excess fullness of the after body lines over those of an equally balanced ship of the same nominal block coefficient. This difference existing is, however, too great to be credited entirely to this cause.

There is another explanation for the excess of actual power over estimated in the case of the fifth vessel, and this is, in all probability, the correct one. It will be noted that the value of K in this case is 1.31, while that of Z_p is —.382. Taking .382 — log K as the value of Z_p corresponding to the total work (load fraction) being delivered by the propeller, the value $\frac{e.h.p.}{E.H.P.}$ corresponding to this is found from Fig. 7 to be .555.

Plotting this point on Fig. 8 with $v \div V = .8076$ as ordinate, it will be found to fall below the curve of $S = .2175$ for vessels of type 2, slips of the second order. Now assume that the existence of a K loss produces earlier cavitation and that the propeller in the case in question is cavitating. The value of $\frac{e.h.p.}{E.H.P.}$ corresponding to the point on the curve $S =$ .2175 whose ordinate is $\frac{v}{V} = .8076$ is approximately .525 and the value of Z_p corresponding to this is .29; then the increase log factor due to cavitation is .29 — (.382 — .11727) = .02527 and the corrected value of $I.H.P._a$, taking cavitation into account, will be:

$$\text{Log } I.H.P._{ac} = \log I.H.P._a + .02527 = 3.43503.$$

$I.H.P._{ac} = 2{,}723$, which corresponds very closely with the actual power 2,700.

Now K undoubtedly does produce earlier cavitation; therefore, when deciding upon the design point on Fig. 8 it should be so located that the $\frac{e.h.p.}{E.H.P.}$ point, corrected for K, will fall well above the basic curve of S for the vessel. The remainder of the vessels in the McEntee problem plot above their curve of S when the correction for K is made and therefore are free from any cavitation.

Assuming that the above is correct, as it undoubtedly is, the supposition that model tank trials give no indication of cavitation is incorrect, as in the case just discussed, the model propeller is clearly indicating "dispersal of the thrust column," a term which will be explained later.

PROBLEM 2.—VESSEL OF TYPE 3

$L.L.W.L. = *$
$B = *$
$H = *$
$\frac{H}{B} = .269$
$\frac{B}{L.L.W.L.} = .124$
$\frac{2L.A.B.}{H} = 30.09$
Nom. $B.C. = .577$
$B.C.$ on $A - B = .418$
$B.C.$ on $A - B$ cor. for $\frac{H}{B} = .34$

Slip $B.C.$ on $X = .45$; $S = .0775$
$K.B.C. = .51$
$K = 1$
Number of propellers $= 4$
$D = *$
$P = *$
$\frac{P.A.}{D.A.} = *$
Blades $= 3$
Form $=$ standard
$T.S. = *$
$P \times R = 5.772$
$1 - S = .9225$
$V = 52.55$
$I.T._D = *$
$I.H.P. = 225{,}740$
$P.C. = .525$
$E.H.P. = 118{,}510$
$S.H.P. = 207{,}680$
$v = 32$
$\frac{v}{V} = .609$
$e.h.p. = *$ (bare hull) $= *$ (est. all append.)
$\frac{e.h.p.}{E.H.P.} = *$
$Z_p = *$
$K = 1$
$S.H.P._d = 155{,}380$
Act. power $=$ between 150,000 and 155,000

* The data omitted are confidential and therefore cannot be made public.

Having illustrated the method followed in estimating the power required to drive a vessel at any given speed against the resistance existing at that speed, it remains to explain the method of estimating the revolutions at which the propeller will turn under these same conditions of estimated power and speed, and this will be taken care of as follows:

Estimate of Revolutions Under Other Than Basic Conditions of Operation

Commander S. M. Robinson, whom the author had the pleasure of calling his assistant during the period of the great war, by laying down curves of revolutions of propellers of standard form with actual speeds through the water as abscissas derived a curve of exponents y for which the equation is as follows:

$$y = \frac{v}{v-1}\left(2.626 + \frac{5861.3}{28{,}045 + (v-25)^4}\right).$$

A curve of log y was also erected on v as abscissas and the values of the logs of basic V^y and v^y were denominated log A_V and log A_v.

The equation for apparent slip at any speed was found to be:

$$s = S\,\frac{I.H.P._d \times V^y}{I.H.P. \times v^y} = S\,\frac{KV^y}{10 Z_p v^y},$$

or

$$\text{Log } s = \log S + \log I.H.P._d + \log A_V - \log I.H.P. - \log A_v$$
$$\text{Log } s = \log S - Z_p + \log A_V - \log A_v \text{ when } K = 1.$$

Now let $\log A_V - \log A_v = Z_v$, and, plotting it on values of $\frac{v}{V}$ as shown by curve 1 on Fig. 7, it will be found to be expressed by the equation:

$$Z_S = 2.861 \log\left(\frac{V}{v}\right) - .0788.$$

This curve reaches the value $Z_s = 0$ at a value of $\frac{v}{V} = .9385$, and this value of 0 is retained at least until $\frac{v}{V} = 1$ is reached. Beyond that the question of cavitation enters and certain variations may occur, depending upon the values of $\frac{v}{V}$ and the corresponding values of $\frac{e.h.p.}{E.H.P.}$.

The form of the equation for apparent slip where $K = 1$ now becomes $\log s = \log S - Z_p, + Z_s$ and when $Z_p = Z_s$ $s = S$; that is, when the vessel is loaded down so that at any fraction of load $\frac{e.h.p.}{E.H.P.}$ and corresponding speed v, when Z_s for $\frac{v}{V} = Z_p$ for $\frac{e.h.p.}{E.H.P.}$, the apparent slip has become equal to the basic slip and the propellers are passing into the cavitating zone, with or without loss, depending upon the quality of the wake which the vessel carries.

To illustrate the method of estimating revolutions when cavitation does not exist the calculations for Problems 1 and 2 will be continued.

Before leaving the subjects of estimation of power and of revolutions, it should be of interest to note that none of the

ESTIMATE OF REVOLUTIONS

Problem 1.—$v = 11$

$S.H.P._d$	1,716	1,827	1,970	2,220	2,569
$\frac{v}{V}$	.7348	.7479	.7614	.785	.8076
Z_S for $\frac{v}{V}$ (Fig. 6 — 1)	+.298	+.280	+.25	+.217	+.182
s	.1010	.1142	.126	.1510	.1798
$R_d = \frac{v \times 101.33}{P \times (1-s)}$	84.07	85.31	86.46	89	92.14
Actual revolutions	84.5	85.5	86	88	93.2

PROBLEM 2.—$v = 32$

$S.H.P._d$	155,380	Z_S	+.53
$\frac{v}{V}$	.609	s	.1965
		R_d	209.6
		Actual revolutions	208+

vessels covered by the above problems was used to any extent whatever in the derivation of the curves of design and estimating.

The processes of estimating under normal conditions having been explained, it is now necessary to take up the same subject under abnormal conditions of load, which abnormal conditions are treated under the general head of cavitation.

(*To be continued.*)

The Marine Fire Hazard*

BY FREDERICK S. TITSWORTH†

FIRE on shipboard is generally considered to be one of the most dreaded perils of the sea. It may be said without exaggeration that one-seventh of all the property lost at sea is lost by fire damage. Of the total of 835 fires which have occurred during the last six years on vessels of 2,500 gross tons or over, 544, or 65 percent, originated below decks. Of these 544 originating below decks there were 392 cargo fires, or 72 percent of all fires originating below decks were cargo fires.

Reference to the annual reports of the United States Steamboat Inspection Service covering the period 1910-1920, inclusive, reveals that of all the lives lost on the sea from all causes, approximately 2 percent were lost by fire. During the period 1916-1920, inclusive, this percentage was increased to 7. Statistics show that the casualties and deaths resulting from fire on board ship are abnormally large and proportionately far greater than they are on land.

Causes of Marine Fires

Listed below are a few of the more important causes of ship fires. These are not given in the proper order of importance or frequency of occurrence:

- Oxidation of bunker coal
- Fuel oil (breaking of pipes, careless filling of tanks, inflammable vapor)
- Defective wiring
- Harbor fires, communicated from wharves
- Spontaneous combustion in cargo
- Carelessness of stevedores and crew (smoking—matches)
- Friction due to shifting of cargo
- Rodents
- Lamps and torches
- Fumigation
- Stoves
- Lightning
- Steam pipes.

It will be noted that, while many of these causes can be eliminated by special precautions of the master and crew, the majority of them are impossible of prevention in spite of all the ship operators can do. Cargoes accepted and stored are boxed in such a way as to make it utterly impracticable to ascertain their contents or whether sufficient care has been taken in packing.

Remedial Suggestions

In 1905 Section 4470 of the United States Revised Statutes was passed by Congress, providing that every steamer carrying passengers or freight shall be provided with suitable pipes and valves "attached to the boiler to convey steam into the hold and to the different compartments thereof to extinguish fire." Thus the means to extinguish fire was made mandatory, but there is no provision made for *detecting* the presence of fire. One of the fundamental principles in fighting a fire is to begin the attack as soon as combustion develops.

Based upon authority delegated by Congress in Section 4472, referred to above, the Board of Supervising Inspectors of the Steamboat Inspection Service promulgated the following regulation entitled "Automatic Fire Alarm System" (Par. 14, Ocean and Coastwise, Rule IV, Edition of May 14, 1920):

> "All steamers of more than 150 feet in length under the jurisdiction of the Steamboat Inspection Service, whose construction is contracted for after June 30, 1916, which are provided with staterooms or other sleeping quarters for passengers, shall be equipped with an efficient fire alarm system or indicator which will automatically register, at some central point or station where it can be most quickly observed by the officers or crew of the steamer, the presence or indication of fire in the staterooms and *various other compartments of the steamer which are not accessible to the observation of officers or crew.*"

Although this would seem to require a fire indicating system in all the inaccessible holds and other compartments of every passenger vessel, it has never been the practice to require fire detecting systems in any other part than the staterooms and superstructure of passenger vessels. No fire detecting system has ever been required in the holds and inaccessible cargo compartments of passenger or non-passenger vessels, although statistics show that the greatest danger from fire on shipboard lies in the holds and cargo compartments on passenger and non-passenger vessels, the hazard being greater in vessels of the latter class.

The American Delegation at the International Conference on Safety of Life at Sea, which took place in London on November 10, 1913, and January 20, 1914, presented a preamble and resolutions on fire, its prevention, detection and extinguishing, which was unanimously adopted, the resolution reading as follows:

> "RESOLVED: That the American Delegation proposes the following principle for the consideration of this sub-committee, and requests its adoption and endorsement:
>
> "'That the several States signatory to this Conference agree to enact such legislation as will to the fullest possible extent provide for the prevention, detection and extinguishng of fire on shipboard, the details of the installation and application of such law to be regulated and arranged by the several signatory States.'"

Unfortunately, the forward step contemplated to be taken as recommended by this International Conference was never taken. In spite of the fact that the resolution was presented by the American Delegation, the Convention itself was not ratified by the United States.

From the above does it not seem expedient at this time for Congress to amend the Federal law and compel the installation of suitable fire detecting appliances on all passenger and non-passenger ships, particularly in the inaccessible holds and cargo compartments; such systems only to be permitted as may be approved after full inspection of the Steamboat Inspection Service?

Such a system of fire detection and extinction for use on board ship should provide the following:

(1) The means to ascertain when and where combustion is taking place before active conflagration begins, in order that the extinguishing medium may be applied immediately at the source of the fire without needlessly damaging cargo by applying an excess quantity of the medium or by applying it where it is not needed.

(2) The means to fight the fire without opening hatches or endangering the lives of the crew by sending them into smoke-filled compartments to investigate the location of the fire or to extinguish it.

(3) Means to fight the fire without unnecessarily alarming the passengers and crew.

(4) Means to determine whether or not the fire is gaining headway and spreading to other parts of the ship.

(5) Means to determine whether the fire breaks out again after having been supposedly extinguished.

---

* From a paper presented before the American Society of Safety Engineers, New York, February 26, 1921.

† Walter Kidde & Company, Inc., New York.

Arc Welding Equipment at Newport News Yard

Centralized Power Station Proves More Economical Than Portable Sets

THE Newport News Shipbuilding and Dry Dock Company, Newport News, Va., has simplified the problem of furnishing power for arc welding wherever it is needed in the shipyard by concentrating its generators in one place, and distributing current to certain points from this substation. This method has proved best suited to the local conditions, and has shown an economic gain over the use of a number of single operator portable sets, not only in first cost, but in upkeep. The system is not used for welding on ships that are afloat. There welding is done with portable welding sets, the welding machine lead being grounded to the ship to prevent electrolytic action on the hull.

Several large machines working in parallel will, due to the diversity factor, permit the operation of many more welding stations than is indicated by the combined rated capacity of the generators. For example five generators having a combined rated capacity of 30 welding stations actually supply a total of 40 stations.

Equipment of the Substation

The substation contains five General Electric Company motor generator sets with their control switchboards, power being received at 440 volts alternating current from the main power station. The motor generator sets each consist of a 440 volt, 140 horsepower squirrel cage induction motor direct connected to a 94 kilowatt, 1,250 ampere 75 volt, constant potential, compound wound direct current generator, and have centrifugal safety switches for overload release. The compensators for starting the motors are mounted on the wall opposite each motor.

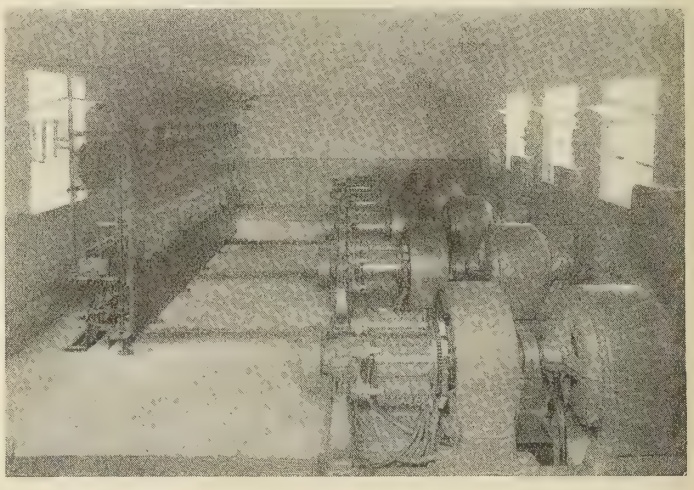
The control system for the direct current welding power consists of a switchboard which combines five standard panels, one for each generator. Each panel carries a circuit breaker, ammeter field control rheostat, voltmeter plug in receptacle, and paralleling switches for connecting the generators to the line. The voltmeter is bracket mounted, and electrically connected to the plug receptacles on the panels.

The five direct current generators may be connected, one or more at a time to a "negative" common bus or feeder circuit which is formed of five power lines. The five negative lines are carried on shipway crane trestles and branched to serve nine shipways. The "positive" return is made common by bonding all the trestles together and tying them to a positive return bus. In order to complete the welding circuit through the ships on the ways, their keels are bonded to the nearest trestle, thus completing the circuit.

How Welding Stations are Obtained

Welding stations are obtained by tapping the negative distribution lines at frequent intervals and connecting the tap to disconnecting switches located on trestles within easy reach of the operators. Between the disconnecting switches and the taps, permanent series grid resistors are inserted. The operator, to start welding, simply has to connect his electrode lead to a plug receptacle. An additional light weight portable resistor between the switch and his electrode enables the operator to adjust the current in the arc to the desired value. Such a system eliminates all temporary wiring, with the exception of the electrode leads, therefore doing away with the inconvenience and danger which are liable to arise from temporary wiring. Another advantage is that the voltage can be kept constant at all points by one operator in the substation.

As far as the economical side is concerned, in the first place this installation permits the operation of approximately 40 welding stations. The first cost of forty individual portable sets ready to operate would be about 10 percent less than the corresponding cost of the permanent installation, including building, wiring, etc., but, even so, the permanent installation is more economical for several reasons. Repairs to portable equipment made necessary by constant moving over rough ground and general knocking about would be considerable. Repairs to the permanent installation, and maintenance too, are a minimum in comparison. From a standpoint of general operating charges, such as trucking, labor and lost time, not to mention the inconveniences and danger of temporary and hence more or less careless wiring, the permanent installation, with wiring installed out of the way, good regulation and the absence of delay in moving and wiring up to the individual job, is decidedly superior. These advantages are named without any consideration of comparative power consumption.



Five 1,250-Ampere Generator Sets Used to Supply Current for Forty Welding Stations

Miniature Searchlights Used to Amplify Smoke Indications in Fire Detecting System

THE Rich system for protection against fire on board a vessel consists essentially of converting the steam smothering lines compulsory on all ships into smoke indicators. Pipes leading from each hold and compartment to the main steam line are continued up to the wheel house, where they are grouped in a detecting cabinet. When fire starts in the hold, small suction fans operating continually in the base of the cabinet exhaust the first trace of smoke through flares at the ends of the pipe lines into the cabinet against a dark background. Each tube end is properly marked so that the compartment in which the fire is smoldering can be determined immediately and the steam turned through the pipe line into the proper space to smother the fire.

To increase the certainty of detecting the first sign of smoke an underlighting system of miniature searchlights has been arranged in the base of the cabinet so that a beam of light is directed from the end of each pipe. Any smoke now issuing from the flare is thrown into prominence immediately. The searchlight effect is obtained by means of two ordinary incandescent lamps in the base of the cabinet, the light from which is directed against a system of lenses and mirrors set in brass castings in the pipe lines. When smoke is once indicated in the detecting cabinet, live steam is turned through the pipe lines into the compartment on fire. Fires may thus be controlled before they have reached dangerous proportions.

Balancing Engines

With Special Reference to Internal Combustion Engines

BY C. H. PEABODY, DR. ENG.

THE balancing of engines has been treated as a recondite subject to be handled carefully by experts; even now many believe the direct mathematical treatment to be too difficult, and in order to avoid it employ graphical processes or approximate calculations. And yet ready methods with convenient tables are to be found in certain text-books which, however, do not appear to be generally known. The computation of tables is tedious, but that concerns the practitioner as much and no more than the compilation of tables of logarithms. Even some of the obvious applications to automobile engines have been heralded as revolutionizing discoveries.

Acceleration

Some of the trouble may be due to the fact that, while all can talk glibly of velocity and acceleration, the fundamental conception may not be clear and mystery leads to obscurity. Perhaps a simple presentation of the fundamental may be interesting even to the initiated and may clear away mysteries to those less familiar.

If a heavy body is dropped it will fall about 16 feet the first second, 64 the next second and so on, as given in the following table:

Time	Distance	Velocity	Acceleration
0	0	0	..
1	16	32	..
2	64	64	32
3	144	96	32
4	256	128	32
5	400	160	..
6	576	...	..

If some one wants to be finicky, he will add a small fraction to the 16, depending on latitude and altitude, and will

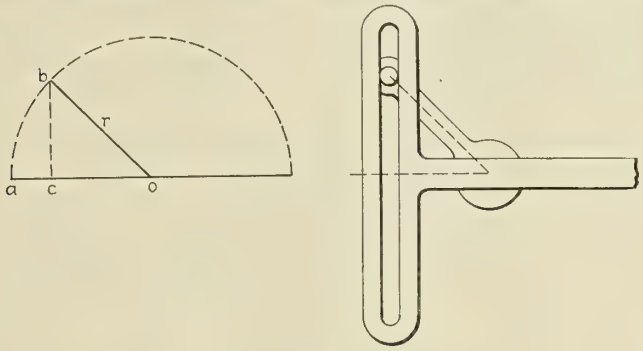


Fig. 1

begin to worry about atmospheric resistance; but let the table be granted as a first approximation. We are familiar with velocity as given by the speedometer, especially if we have reason for exceeding the speed limit, but that is in miles per hour. If the mile were only 6,000 feet ashore as it is at sea, then sixty miles an hour would be 100 feet per second. In what follows velocity per second will be used. Now the way to test velocity is to measure the time over a known distance. That is what the traffic officer does, but many would like to believe he does not know how to calculate.

For first approximation let us calculate the velocity of falling by this method. In two seconds a body falls 64 feet, and dividing by two gives the velocity as 32 feet at the middle point of time. In the two seconds from 1 to 3 the body falls 144 minus 16 feet, or 128 feet, half of which is 64, the velocity at 2 seconds, and so on through the table. The rate of increase in velocity is called acceleration; it can be computed from the velocity by an extension of the same method. Thus, the velocity at the end of one second is 32, and at the end of the third second it is 96; half the difference is 32. This last is the acceleration due to gravity, which is commonly quoted as 32.2 and which gets into almost all equations for dynamics.

It appears from the above discussion that the acceleration due to gravity is constant; it is constant at a given place. Consequently the method used is exact, because a uniform increase in velocity will make a body fall half as far in a second as it would fall at constant full velocity. The real proof of the gravitation system is its use in calculating the orbits of the moon and other heavenly bodies.

Mass

It has been agreed that force shall be measured by the product of the mass by the acceleration. A pound weight is pulled down by gravity with the force of one pound. Its mass is, therefore,

$$1 \div 32.2 = \frac{1}{32.2} = \frac{1}{g},$$

and the mass of a body weighing w pounds is

$$m = \frac{w}{g}.$$

Physicists like to speculate about mass, and engineers are not uncommonly afflicted by the same tendency. The usual definition is that mass is the amount of matter in a body; which does not mean anything and we will let it go at that.

Harmonic Motion

The next simplest acceleration to that of gravity is acceleration of a slotted crosshead, shown in Fig. 1. Suppose that the crank starting at the dead point a has moved through the angle a-o-b, and that the crosshead has moved the distance $ac = r - r \cos a\text{-}o\text{-}b$. To find the velocity at this position we will divide a small movement by the time taken to go to it. For a first approximation we will take a movement of 10 degrees of the crank, half on one side and half on the other. Thus if a-o-c is 30 degrees we will calculate for 35 degrees and 25 degrees, giving

$$ac_{35} = r - r \cos 35 \text{ degrees} = r - 0.9063r,$$
$$ac_{25} = r - r \cos 25 \text{ degrees} = r - 0.8192r,$$

the difference being $0.0871r$.

Now the time taken by the crank to go 10 degrees will be

$$\frac{10}{360} \div \frac{n}{60} = \frac{1}{36} \times \frac{60}{n},$$

where n is the number of revolutions per minute. This time is likely to be a small fraction of a second.

Dividing the distance by the time, we have for the velocity

$$v = \frac{nr}{60} \times 36 \times 0.0871 = \frac{nr}{60} \times 3.136.$$

The next operation is to multiply and divide by the ratio of the crank to the circumference of the circle; that is, by

$$2\pi = 2 \times 3.1416 = 6.2832.$$

This looks a good deal like a trick, especially as we get a desirable result; that is,

$$v = \frac{2\pi nr}{60} \times \frac{3.136}{6.2832} = \frac{2\pi nr}{60} \times 0.5 \text{ (approximately)},$$

where we may recognize that 0.5 is the sine of 30 degrees, so that the velocity becomes

$$v = \frac{2\pi nr}{60} \text{ sine 30 degrees.}$$

The reason for using the trick is that the differential calculus shows that this is the exact expression for the velocity. In fact, we may write, as a general expression,

$$v = \frac{2\pi nr}{60} \text{ sine } a\text{-}o\text{-}b = \frac{2\pi nr}{60} \text{ sine crank angle.}$$

The next step is to get the acceleration by dividing a small increase in velocity by the time required to gain it. The numerical work is like that just given, taking sines at 35 degrees and 25 degrees and their difference. The time required is the same as that used, and we resort to the same trick of multiplying and dividing by 2π. Omitting the numerical work, we may write the result as

$$a = \frac{4\pi^2 n^2 r}{3{,}600} \text{ cos 30 degrees;}$$

or in general for any crank angle

$$a = \frac{4\pi^2 n^2 r}{3{,}600} \text{ cosine crank angle.}$$

Instead of making calculations for each particular case, it is convenient to compute a table, and since the length of the crank and the number of revolutions per minute vary from engine to engine we may compute an acceleration factor

$$\frac{a}{n^2 r} = \frac{4\pi^2}{3{,}600} \text{ cos crank angle.}$$

TABLE I.—ACCELERATION FOR HARMONIC MOTION

Multiply factors by n^2r

n = revolutions per minute

r = length of crank in feet

Sign of factors negative 90 degrees to 180 degrees and 180 degrees to 270 degrees

Crank Angles	Acceleration Factor	Crank Angles	Acceleration Factor
0-360	0.0110	100-260	0.0019
10-350	0.0108	110-250	0.0038
20-340	0.0103	120-240	0.0055
30-330	0.0095	130-230	0.0071
40-320	0.0084	140-220	0.0084
50-310	0.0071	150-210	0.0095
60-300	0.0055	160-200	0.0103
70-290	0.0038	170-190	0.0108
80-280	0.0019	180-180	0.0110
90-270	0.0000		

To illustrate the use of this table of accelerations, let us solve a problem. Since slotted crossheads find little use in practice, the problem must be made up and may as well be a simple one. Suppose that a pump with a slotted crosshead makes 60 revolutions per minute, that the length of the crank is 6 inches and that the piston, piston rod and crosshead together weigh 100 pounds.

The acceleration factor at the beginning of the stroke from the table is 0.0110. This factor is to be multiplied by

$$n^2 r = 60^2 \times \tfrac{1}{2} = 1{,}800;$$
$$\text{acceleration} = 1{,}800 \times 0.0110 = 19.8.$$

This may be compared with the acceleration due to gravity 32.2 feet per second. The significance of this is that the force required to accelerate the piston and attached parts is less than the weight of them.

Having in mind that a force is measured by the product of the mass and the acceleration, we may now calculate the force at the beginning of the stroke as follows:

$$\frac{100}{32.2} \times 19.8 = 60.2 \text{ pounds.}$$

A little study of the table will give useful information. Thus the acceleration for a crank angle of 60 degrees is half that for 0; the factor is then 0.0055 as compared with 0.0110. For that angle the movement of the piston is

$$r - r \cos 60 \text{ degrees} = r\ (1 - 0.5000) = \tfrac{1}{2}r.$$

That is to say, the piston is then at one-quarter stroke. At 90 degrees the acceleration is zero, and then it changes sign and becomes a retardation, and the force for a retardation is measured by the product of the mass by the retardation (negative acceleration). At the other quarter stroke the factor is —0.0055, and at the end of the stroke the factor is —0.0110. From this we see that the acceleration decreases uniformly during the first half stroke and that the retardation increases uniformly during the second half stroke.

Since the factors are multiplied by n^2r, it is evident that the accelerating force increases as the square of the revolutions and as the length of the crank. Thus, if we double the speed, the accelerating force becomes four times as great. On the other hand, doubling the stroke (or the crank) only doubles the accelerating force. Either method would double the capacity of the pump. Of course doubling the stroke would mean building a new pump, while doubling the revolutions would mean wearing the pump out sooner.

Crank and Connecting Rod

The reason for handling the balancing of engines so gingerly is seen when we find from Fig. 2 that the displacement of the piston from the beginning of the stroke is

$$s = l + r - r \cos \theta - \sqrt{l^2 - r^2 \sin^2 \theta}.$$

The derivation of this equation and the method of computing the acceleration will be put in an appendix following

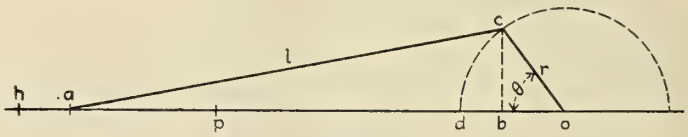


Fig. 2

this section of the discussion of balancing engines. Those familiar with differential calculus will follow the work readily. For our present purpose we may use the following table, which has been properly computed and verified:

TABLE II.—TABLE FOR ACCELERATION OF CROSSHEAD

Multiply factors by n^2r

n = revolutions per minute

r = length of crank in feet

Crank Angles	Ratio of Connecting Rod to Crank 4	4½	5	5½
0-360	0.01371	0.01340	0.01316	0.01296
10-350	0.01338	0.01309	0.01291	0.01268
20-340	0.01243	0.01219	0.01200	0.01184
30-330	0.01091	0.01075	0.01062	0.01051
40-320	0.00893	0.00886	0.00881	0.00877
50-310	0.00662	0.00665	0.00669	0.00672
60-300	0.00411	0.00427	0.00439	0.00449
70-290	0.00161	0.00185	0.00205	0.00221
80-280	0.00075	0.00044	0.00020	0.00000
90-270	0.00283	0.00250	0.00224	0.00203
100-260	0.00456	0.00425	0.00400	0.00381
110-250	0.00589	0.00565	0.00545	0.00529
120-240	0.00685	0.00670	0.00658	0.00648
130-230	0.00749	0.00745	0.00741	0.00738
140-220	0.00788	0.00794	0.00799	0.00804
150-210	0.00808	0.00825	0.00837	0.00848
160-200	0.00818	0.00842	0.00861	0.00877
170-190	0.00822	0.00850	0.00869	0.00892
180-180	0.00822	0.00853	0.00877	0.00897

The sign of the acceleration constant is positive from 0 degrees to 70 degrees, and negative from 70 degrees to 180 de-

grees. From 180 degrees to 290 degrees the sign is again positive and finally is negative from 290 degrees to 360 degrees. The factor becomes zero somewhere between 70 degrees and 80 degrees.

To show the use of the table, we will compute the accelerating force acting on the piston and connecting rod of an automobile engine. In order to have a real problem the writer stepped into the nearest automobile station, which happened to deal in the Jordan car. Parts were very courteously produced and weighed, with the following results:

	Pounds
Piston, rings and pin	3.25
Connecting rod	3
Crank pin end	2
Wrist pin end	1

The stroke is 5.25 inches and the length of the connecting rod is twice as much, i. e., it has four times the length of the crank. The body of the rod is slender and it will be sufficient to add the weight of the wrist pin end to the weight of the piston, making the combined weight 4¼ pounds. The weight of the crank pin end may be assumed to be applied at the crank pin; its influence will be considered later. The stroke of the piston being 5¼ inches, the length of the crank in feet will be

$$\frac{5\frac{1}{4}}{2 \times 12}.$$

To get the acceleration, we will take the acceleration factor from Table II at 0 degrees and multiply by n^2r. To find the force required to accelerate the piston we must further multiply by the mass—that is, by the weight divided by 32.2. Finally we shall have for the force required to give motion to the piston at the top end of the stroke

$$(750)^2 \times \frac{5.25}{2 \times 12} \times 0.01371 \times \frac{4.25}{32.2} = 223 \text{ pounds.}$$

A similar calculation for the bottom end of the stroke, using the factor 0.00822 from Table II, is 134 pounds.

There are two very important pieces of information to be had from this calculation. First, that we are dealing with large forces and, second, that the accelerating forces at the two ends of the stroke are very unequal. The top end force is more than fifty times the weight of the piston and attached parts, and it is nearly 1.7 times the force at the bottom end. This information cannot be over-emphasized if we are to give intelligent attention to balancing engines.

We will pause to bring out one more point from Table II before proceeding, namely, that the inequality of the acceleration at the two ends of the stroke decreases rapidly with the length of the connecting rod. Thus when the rod is 5½ times as long as the crank the ratio drops to 1.4; this shows the advantage of longer rods.

Appendix

In Fig. 2 let o be the center of the crank shaft, let hp be the stroke of the crosshead, let r be the length of the crank, and l be the length of the connecting rod; then the displacement of the piston from the beginning of the stroke is

$$s = ha = hd + do - ob - ab.$$

Here hd is the length of the connecting rod, do is the length of the crank and the other terms are

$$ob = r \cos \theta,$$

$$ab = \sqrt{(ac)^2 - (cb)^2} = \sqrt{l^2 - r^2 \sin^2 \theta},$$

so that

$$s = l + r - r \cos \theta - \sqrt{l^2 - r^2 \sin^2 \theta}.$$

It is convenient to give the crank angle in terms of the angular velocity α of the crankpin, so that if t is the time required for the crank to pass from the dead point d to the position oc, then

$$\theta = \alpha t.$$

Consequently the displacement of the crosshead from the beginning of the stroke is

$$s = l + r - r \cos \alpha t - \sqrt{l^2 - r^2 \sin^2 \alpha t}.$$

The velocity v is found by differentiating with regard to t.

$$v = \frac{ds}{dt} = \alpha r \sin \alpha t + \frac{\alpha r^2 \sin \alpha t \cos \alpha t}{\sqrt{l^2 - r^2 \sin^2 \alpha t}}.$$

$$v = \alpha r \sin \alpha t \left\{ 1 + \frac{r \cos \alpha t}{\sqrt{l^2 - r^2 \sin^2 \alpha t}} \right\}.$$

Differentiating again to get the acceleration

$$a = \frac{dv}{dt} = \frac{d^2s}{dt^2}$$

$$= \alpha^2 r \cos \alpha t \left\{ 1 + \frac{r \cos \alpha t}{\sqrt{l^2 - r^2 \sin^2 \alpha t}} \right\}$$

$$+ \alpha r \sin \alpha t \left\{ - \alpha r \sin \alpha t \, (l^2 - r^2 \sin^2 \alpha t)^{-1/2} + r \cos \alpha t \, [(l^2 - r^2 \sin^2 \alpha t)^{-3/2} (\alpha r^2 \sin \alpha t \cos \alpha t)] \right\}$$

$$a = \alpha^2 r \left\{ \cos \alpha t + \frac{r (\cos^2 \alpha t - \sin^2 \alpha t)}{\sqrt{l^2 - r^2 \sin^2 \alpha t}} + \frac{r^3 \sin^2 \alpha t \cos^2 \alpha t}{(l^2 - r^2 \sin^2 \alpha t)^{2/3}} \right\}.$$

These equations may be written as follows:

$$s = r \left\{ 1 + \frac{l}{r} - \cos \theta - \sqrt{\left(\frac{l}{r}\right)^2 - \sin^2 \theta} \right\}.$$

$$v = \frac{ds}{dt} = \alpha r \sin \theta \left\{ 1 + \frac{\cos \theta}{\sqrt{\left(\frac{l}{r}\right)^2 - \sin^2 \theta}} \right\}.$$

$$a = \frac{d^2s}{dt^2} = \alpha^2 r \left\{ \cos \theta + \frac{\cos 2\theta}{\sqrt{\left(\frac{l}{r}\right)^2 - \sin^2 \theta}} + \frac{\sin^2 2\theta}{4 \left\{ \left(\frac{l}{r}\right)^2 - \sin^2 \theta \right\}^{3/2}} \right\}$$

The calculation of the factors for Table II is made by replacing the angular velocity α by its value $\frac{2\pi n}{60}$ and then solving for $\frac{a}{n^2 r}$ so that

$$\frac{a}{n^2 r} = \frac{4\pi^2}{3{,}600} \left\{ \cos \theta + \frac{\cos 2\theta}{\sqrt{\left(\frac{l}{r}\right)^2 - \sin^2 \theta}} + \frac{\sin^2 2\theta}{4 \left\{ \left(\frac{l}{r}\right)^2 - \sin^2 \theta \right\}^{3/2}} \right\}$$

So far as the writer knows, this equation was first derived by Professor Gaetano Lanza about 1885 and was used by him for computing tables of acceleration. A complete treatment of the dynamics of reciprocating motion and many other motions is given in his "Dynamics of Machines." The discussion here presented is abstracted from the writer's "Computations for Marine Engines," and the tables here given are taken from that book with the permission of John Wiley & Sons, the publishers of both books mentioned above.

(To be concluded.)

Marine Engineering

Published Monthly by

ALDRICH PUBLISHING COMPANY

In Conjunction With

SIMMONS-BOARDMAN PUBLISHING COMPANY

6 East 39th Street and Woolworth Building, New York

F. B. WEBSTER, Editor
H. H. BROWN, Managing Editor

S. M. Phillips, Associate Editor
A. J. Kaufmann, Associate Editor
L. S. Blodgett, Associate Editor
W. Z. Gardner, News Editor

Contributing Editors

Rear Admiral C. W. Dyson, U. S. N.
Commander S. M. Robinson, U. S. N.
Professor C. H. Peabody
Captain C. A. McAllister, U.S.C.G. (Retired)
William Gatewood
H. McL. Harding
William T. Donnelly
James L. Bates

WE GUARANTEE that of this issue 6,600 copies were printed; that of these 6,600 copies 5,308 were mailed to regular paid subscribers, 330 were provided for counter and news company sales, 263 were mailed to advertisers, 85 were mailed to employees and correspondents and 614 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were, 39,200, an average of 7,840 copies a month.

Marine Engineering is a member of the Associated Business Papers, Inc. (A. B. P.), National Association of Periodical Publishers, Inc., New York Business Publishers Association and the Audit Bureau of Circulations (A. B. C.).

The Shipping Board

THE mere appointment of a new chairman for the United States Shipping Board will not end its troubles. As matters now stand, the chairman is such in name only; for the Merchant Marine Act, 1920, says, "The duties of the board may be so divided that under its supervision the directorship of various activities may be assigned to one or more commissioners." While "may" is not "shall," nevertheless no specific authority or assignment is given to the chairman, and the board is actually functioning as a several-headed rather than a single-headed body.

What is needed is a real chairman with real authority, the whole commission to function just as the board of directors of any well-organized business institution functions. It should confine its deliberations largely to policies, leaving it to well paid, competent subordinates to carry out those policies. This plan is especially essential because it is probable that but few if any of the commissioners will be drawn from the one place from which all should be chosen—the American merchant marine field. If each member of the board is to continue to function as in the past, with discretion as to the different departments of ship operation; if the active manipulation is to rest with a lot of incompetents; and if master and man alike are to be subject to the beck and call of politicians, then better by far that the whole board be legislated out of existence and its powers transferred to the Department of Commerce. As a matter of fact, why not that course anyway?

Obsolete Tonnage

ACCORDING to Sir Owen Phillips, Great Britain has over 3,000,000 gross tons of merchant ships that have been over twenty years in service. Not only has Great Britain a large number of old vessels but all other maritime countries have kept in service and resurrected anything in the shape of a ship that would keep afloat. Although there are certain routes where obsolete vessels may still be profitably kept in service the greater portion of these old timers cannot hope to compete with newer ships in the strenuous times that are before us and they should be broken up and given to the junk man.

Although the greater part of our merchant fleet is of recent construction, many of the ships that are at present tied up, including wooden vessels and also steel ships which have not received proper care, might properly be classed as obsolete. In addition to this, and due to the fact that the most of the vessels built during the war were designed for one purpose, we have a number of ships that will be useless until normal trade is resumed. There are a number of special types, however, including passenger vessels and refrigerator ships, of which latter type Great Britain has 272 built and 49 building, that we could profitably use even if they had been a fairly long time in service.

In addition to the special types of vessels that we are in immediate need of, the fact that ships do grow old and become antiquated in about 20 years is another source of encouragement to the shipbuilders because the world's tonnage cannot decrease at the rate of 5 percent per annum for any considerable length of time without a demand for new tonnage to make up the deficiency.

Vessels for Lighthouse Service Urgently Needed

THE Lighthouse Service of the Bureau of Commerce will require in the next three years at least thirty new ships, consisting of light vessels and tenders. While the average age of an ordinary ship is twenty years, of the light vessels now in use twenty are more than thirty years old and of the tenders seventeen are more than twenty-five years old. In order to maintain this service efficiently the Lighthouse Bureau has emphatically recommended the construction of at least four vessels a year, but since 1910 only eighteen ships have been built, which is less than half the number that is absolutely necessary to maintain the Service on its former basis, without allowing for any increase. Since 1910, however, this Service has been greatly expanded and the three new districts of Alaska, Porto Rico and Hawaii have been added, which has so increased the work of the tenders that, even were they efficient modern vessels, their present number would be inadequate to maintain the proper service required to render navigation safe.

Many of the present tenders are of an unsuitable type to perform the heavy work that is required of them and some are not even seaworthy. Outside of the fact that both lighthouse tenders and lightships are engaged on very hazardous duty and that their officers and crews should not be required to serve on vessels which are not reasonably safe, it is false economy to keep in commission vessels that are so old that a great deal of extra time and money must be spent in repairing and overhauling.

Considering the vast sums of money that have been spent on our Navy and merchant marine, the relatively small cost of maintaining an efficient Lighthouse Service should be considered from a business standpoint as the best kind of insurance. Light vessels are floating lighthouses stationed on very hazardous positions guarding the dangerous points of the coast and they are equipped not only with lights but

also fog signals, submarine bells, and radio communications, all of which are most indispensable aids to navigation.

The tenders are the arteries by which lighthouses, light vessels and buoys receive the necessary supplies and also inspections and they maintain a continuous patrol of the coast, frequently rendering aid to ships in distress. They handle buoys of great weight and in placing them they must navigate close to reefs and shoals and in waters that other vessels are careful to avoid.

The building of vessels for this service should not be postponed as the fleet is in a seriously depreciated condition. None of the Shipping Board vessels is adaptable, as the ships required are of a highly specialized and staunch type requiring high freeboard, closely spaced frames, special shape of midship section to give the least resistance to the mooring lines and many other features. A great deal can be saved by constructing a number of those vessels of one type at the same time and Congress would do well to consider whether it is not a good business, as well as humane policy, to authorize the construction of these ships at once, even if it is necessary to part with a few cargo vessels at bargain prices to get the money.

The Ter Meulen Plan

THE Ter Meulen Plan, which is receiving very favorable consideration in England, provides a basis for financing the importers of those nations which under present circumstances are unable to obtain long term loan accommodations on reasonable terms in the open market. The details of this plan, which is composed of sixteen sections, have been redrafted by the Provisional Economic and Financial Committee of the League of Nations. It proposes to establish an international commission of bankers and business men of high standing to consider the value of the security that any country is prepared to give as a basis for granting credits to their importers. The commission will determine the gold value of the security and the participating government will be authorized to issue bonds to the amount which is specifically secured out of the revenue of the assigned assets. The participating governments will be free to pledge their own bonds as security for the payment of imports or to lend them to their nationals to be used as collateral for credits or long term loans for approved imports on private account. The bonds cannot be used for any purpose other than security for imports and must be countersigned by the commission.

As the fundamental purpose of this scheme is to make it possible for impoverished countries to secure the raw materials and products that are necessary to start their industries, only those commodities which will assist in stimulating production will be allowed to be imported on this type of security. Each country is to be required to draw up a schedule of approved imports and this with the particulars of each transaction must be registered with the commission. After these bonds are issued the importer may pledge them with the exporter who shall hold them as long as the terms are complied with and return them to the importer when full payment is made. In the event of the importer not fulfilling his contract the exporter may sell the bonds on the public market after giving reasonable notice to the government issuing them, which shall have the first opportunity to purchase.

It will be noted that this scheme takes care of the importer, but leaves the exporter to finance himself. In this country provision has been made for financing the exporter through banking corporations organized under the Edge amendment to the Federal Reserve Act. One of these companies, the Foreign Trade Financing Corporation, has appointed a committee of bankers and business men to study the value of foreign securities and should they decide that the Ter Meulen plan offers a uniform and safe security, and England, who actually buys our products to sell to other countries on credit, apparently thinks it does, then we will have progressed a long way toward solving the financial problems connected with our foreign trade. In any case some means must be found whereby we can sell our surplus products—and this matter is just as vitally important to the farmer, the miner and the manufacturer as it is to our merchant marine.

The Seattle Spirit

NO better method of developing the enthusiastic support of our merchant marine has been shown than the manner in which the new Shipping Board passenger ship *Wenatchee* was welcomed on her arrival in Seattle. Ocean-going ships, excursion boats, naval craft and a mosquito fleet met the liner in the straits of Juan de Fuca and convoyed her all the way to the Queen city. On the way down the sound the vessel was greeted with salvos from the various forts while aeroplanes circled above her and upon her arrival at Smith Cove she was welcomed with the cheers of thousands, the exploding of aerial bombs and the blowing of syrens and whistles. The Governor of the state and the mayors of Seattle and Wenatchee were present and delivered congratulatory speeches making the event of the establishment of an American-owned and operated passenger service between Seattle and the Orient a time of rejoicing.

Seattle has long had transpacific passenger service but it has been furnished by British and Japanese lines and it is most encouraging to note that the warm reception given to the *Wenatchee* argues well that the support that this ship and the four other passenger vessels assigned to the service will get from this community will be of sufficient strength to permit of successful competition with the existing foreign lines.

Seattle has always been a good advertiser of its resources and advantages but on the other hand it has spared neither energy nor capital to accomplish stupendous engineering projects. The scenic city is one of the healthiest in the world but the climate has been supplemented by a determination to make it the cleanest. The hills in the business district have been leveled at an enormous cost and the harbor and inland lakes have been highly developed and connected by a canal so that the port facilities are of the best.

Undoubtedly the city's geographical location, which is materially closer to the Orient than her southern rivals, has had its influence with the Shipping Board in the allocation of the above-mentioned vessels, as the operating cost of a ship of the *Wenatchee* class is approximately $5,000 per day.

However, Seattle wanted the ships, and the business advantages that it will reap as a result of the establishment of this service are many, but what is true of the benefits of an American merchant marine to this city is also applicable to the whole country. It is right to do those things that are proper in an enthusiastic manner and to let the world know it and we are glad to learn of one more evidence that the Seattle spirit is behind our merchant marine.

Standardizing Joiner Work

JOINER work has always been a knotty problem to the marine estimator. Although many methods have been tried for reducing the cost of this important work to a unit basis for estimating, the designers have caused the failure of all by continuing to introduce special features into the wood work aboardship where a duplication of some standard would do just as well and be a great deal more economical.

In conformity to the above ideas it is understood that several yards are designing standard staterooms with a view to incorporating them on new ships to be built. This practice is to be commended as it allows a large part of the work to be carried out with celerity and at less cost without detracting any from the general appearance.

Sale of Shipping Board Vessels

ONE of the most important problems that will confront the new Shipping Board is how are government ships to be sold to private interests in conformity with the plainly expressed principles of the Merchant Marine Act. It has been the fashion lately with some of our most prominent shipowners continually to express the opinion that these ships cannot be sold at any price at the present time. The truth of the matter is that they cannot be sold at anywhere near the price that the Shipping Board has been asking for them or what it would cost to reproduce them, and this state of affairs is largely due to the world-wide depression in business and the lack of indirect or direct protection for American shipping.

Even without protection in the way of subsidies or discriminatory duties these ships could be sold at a price which would enable them to ocmpete on fair terms with foreign ships. What this price should be cannot be arbitrarily fixed at so much a deadweight ton because there is a wide divergence in the types and quality of the ships. Added to this, there is a great difference in the earning possibilities of the various trade routes and also the question of the coastwise trades, which are restricted to vessels flying the American flag.

One prominent shipowner has suggested that the average book values of English vessels be ascertained as a basis for fixing the prices of our government vessels; but if the administration is not going to enforce the preferential rail rates and the discriminatory duties, it is questionable, even then, whether the American vessels can compete with foreign ships having lower operating costs.

Another shipowner, who has been successfully operating a coast to coast service, has suggested a plan for the sale of Shipping Board vessels which deserves our serious consideration. Briefly, it proposes that the ship operator should make a careful study of the operating costs for a particular type of vessel on a particular trade route and from these data decide what price he can pay for a desired ship and have a reasonable chance of success. He is then in a position to make an intelligent bid which the Shipping Board may accept or offer a counter proposal as to what price it will accept. Assuming that the government desires to place its ships in private hands as directed by the Jones Bill, and at a price that will enable the operator to survive, an agreement could be reached or failing this the usual method of arbitration by a third and disinterested party could be obtained. It is believed that if the Shipping Board would meet prospective purchasers on a price based on operating costs there would be very few cases where arbitration would be necessary in order to determine the price and, what is more important, it would then be possible to interest the public in investing in shipping securities.

Our Naval Program

THE present plans of the Navy Department call for the completion in 1925 of 114 of the latest type of warships. Of these vessels 11 are battleships, 6 battle cruisers, 10 light cruisers, 38 destroyers and 43 submarines. These vessels, having a grand total of 842,109 tons displacement, will more than double the present strength of our Navy and make it equal in size and efficiency to that of Great Britain.

No reduction in this program should be permitted either for economic or disarmament reasons. We can better afford to have a Navy adequate in size to efficiently protect our safety and interests than any other nation. If disarmament agreements are entered into they should be on the basis that this country should have as large a share of the international naval police force as any other and if disarmament agreements are not consummated then there are so many reasons why he should have a big navy that it would take more space than we have available to enumerate them.

The Navy should not be looked upon as an aggressive weapon in the sense of being used to conquer other nations. It takes an army to occupy territory and we have no intention of establishing an invasive force, but the Navy can protect our merchant marine and our foreign interests and it can meet in offensive or defensive action a foreign fleet far enough away from our shores to prevent serious interference with our domestic pursuits. It is the cheapest and most efficient protective insurance that we can invest in and the only means of enforcing such principles as the Monroe Doctrine, the Open Door in China and the Freedom of the Seas.

With our long shore line, the Panama Canal and our island possessions, Congress should not hesitate to grant such appropriations as are necessary to complete this program. Business men should exercise not for the purpose of being able to whip somebody but to keep in condition to repel the microbes of disease. A big Navy means that the United States will be kept in physical condition to prevent the germs of envy or discord which still exist among nations as among men from causing our destruction.

LETTERS TO THE EDITOR

New York Marine Exposition

The suggestion of a marine exhibit at New York at the time of the meeting of the Society of Naval Architects and Marine Engineers is a good idea and cannot fail of success. It is the right kind of intensive advertising, bringing to the attention of shipbuilders and ship designers the equipment they need to complete the outfit of their ships; and better yet it will bring the makers and the purchasers of the equipment together personally. It would be still better if the deck officers and the engineers of steamships could get together with the manufacturers and the shipbuilders. They could talk over and compare all kinds of equipment and each of the three groups could give advice and could learn.

C. H. Peabody, Dr. Eng.

Washington, D. C.

The Determination of Brake Horsepower

In an editorial in the March issue of Marine Engineering on "The Determination of Brake Horsepower," reference is made to the electric cradle dynamometer in a way which we feel is confusing to the reader, who would gather from reading it that the electric dynamometer was essentially an unusual or complicated device.

It is perfectly true that the electric cradle dynamometer for very large powers is high in cost compared to the water brake or hydraulic dynamometer, but for flexibility and convenience of operation the electric dynamometer has no equal. The editorial refers to the machine as being used by "electrical engineers." As a matter of fact, it is used far more by mechanical engineers and internal combustion engine designers than by electrical men. We quote below from an address by J. G. Vincent, lately Lieutenant-Colonel in the U. S. Army Air Service, presented to the engineering students at Yale University on May 7, 1920:

"There are two distinct methods of testing an engine; one, a dynamometer test, and the other, a test after installation in the car, truck, tractor, plane or boat, as the case may be. Both kinds of tests are necessary, each method permitting of acquiring certain data indispensable to a complete understanding of the subject. The dynamometer represents a means of absorbing power and may consist of a prony friction brake, a water brake, a fan brake or an electric-cradle dynamometer. I will describe only this latter form, since it is immensely superior to the other types and is universally used, at least in this country."

C. F. Scott,

Manager Apparatus Department, Sprague Electric Works.

New York.

Motorboat Standards

Some conception of what engineering standardization can do for an industry may be gathered from the work that has already been done in this direction by designers and engineers in the automobile field. There are at present more than two hundred definite automotive standards being used, the natural result being an inestimable saving in production costs. What is perhaps even more important, a minimum "factor of safety" has been made a part of some of these standard specifications, thus insuring to the ultimate user of the finished product not only excellence of materials used, but also the prolonged life and sustained performance of the equipment itself.

What has been done in other industries can be done, to a degree, in the motorboat industry. One of our leading builders has aptly stated: "The builders with a large amount of invested capital realize that standardization is imperative, and concerns with only a small capital must either soon come to it or gradually pass out of business."

The Motorboat Standards Division of the Society of Automotive Engineers, embracing a personnel of some of the best-known men in the motorboat industry, has been engaged in the formulation of marine standards and recommended practices for several years past. Some progress has been made, and that committee is now seeking suggestions from builders, designers, engineers and others in the trade as to what practices might be recommended in the construction and equipment of motor craft, with the probability that in due time these practices may find universal favor and be formally adopted as standards. Suggestions may be sent either to the writer or to Mr. Joseph C. W. Van Blerck, vice-president, Society of Automotive Engineers, 29 West 39th street, New York City.

New York. Ira Hand, Secretary,
National Association of Engine & Boat Mfrs., Inc.

NEW BOOKS

Metallic Packing

Metallic Packing. By Julian N. Walton. Pages, 87. Illustrations, 54. Size, 8 by 5 inches. Chicago, Ill., 1920: Crane Packing Company.

This book is being distributed by the Crane Company to designers, manufacturers and operating engineers to assist them in understanding more fully packing problems and to help them in overcoming packing troubles. The theory and practice in using various successful types of packing are thoroughly discussed in the first chapters of the book. Split case and split ring metallic packing preceded the various granulated and plastic types which were intended to meet the demand of flexibility and compressibility. The Crane packing as finally developed embodied the properties of these types with the advantage of full flexibility which had previously been lacking. For packing valve stems and rods, reciprocating rods on pumps and air compressors and the like this material is specially adapted. High speed shafts of centrifugal pumps operating under high pressures depend on leakage through the packing for lubrication. With Crane packing the stuffing box leakage is controlled to the exact amount to provide this lubrication. In turbine practice this packing forms a permanent seal of the steam shaft; for refrigeration and acid service special packing containing wiper rings is used to eliminate any trace of vapor that might pass through the stuffing box. Notes on the design and charts giving the general proportions of stuffing boxes are included in the book for the use of engineers called upon to design stuffing boxes for all services and pressures.

Ore and Coal Carriers Chilore and Lebore

(*Concluded from page 367.*)

is no comparison between the strength of this and the new vessels. It is interesting to compare the *Chilore* and *Cubore*, both ore and coal steamers, as this factor jumps from 2.95 in the case of the *Chilore* to 3.56 for the *Cubore*, although the block coefficient is .02 less in the case of the latter. The Lake ore steamer has a factor in close agreement with the larger Bethlehem steamers, but this comparison is of no particular value on account of the limited draft of the lake vessels and the resulting relatively small deadweight. If this vessel was given a permissible freeboard, the deadweight carried per ton of steel would be very much higher.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

CONDUCTED BY JAMES L. BATES

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permision to do so.

Calculations for Strength of Ships

Q. (1118).—I recently purchased a book on ship production in which appeared the following paragraph:

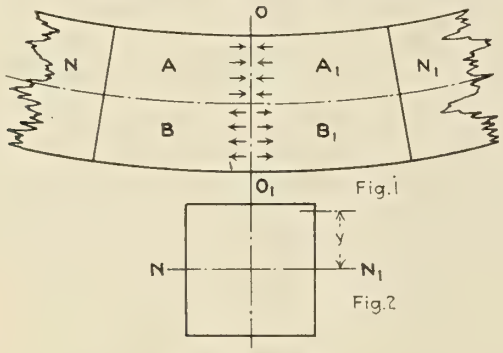
"The maximum bending moment and the point at which it occurs are then determined, and calculations for the strength of the ship at this point are made to see that this strength is sufficient. This is done by finding the moment of inertia of this section and calculating the maximum fiber stress, making use of the ordinary beam formula $\frac{p}{y} = \frac{M}{I}$."

I would like to learn the meaning of the "p," "y," "M" and "I" as used in the above. I take the "M" to mean the bending moment and the "I" the moment of inertia, but cannot understand the "p" and "y" in the above.

L. J. I.

A. (1118).—The formula to which you refer expresses the relationship between bending moment, M; moment of inertia, I; unit stress, p; and the distance from the neutral axis to any given point, usually the outermost, of the cross section, y. (See Figs. 1 and 2.) This relationship holds for beams of uniform cross section and homogeneous material upon which the forces, both of support and load, act in a common plane and perpendicular in each case to the neutral axis of the unbent beam.

A proper understanding of the action of the ship as a girder when subjected at once to the loads due to the weights of her structure, machinery, cargo, etc., and to the supporting forces of the water can be best obtained through a thorough study of the flexure of ordinary beams. Any standard work on applied mechanics, such as "Mechanics of Materials," Merriman; "Mechanics of Engineering," Church; or "Applied Mechanics," Lanza, will afford the basis for such a



Figs. 1 and 2

study. If the information is desired in more compact form, reference may be made to the "Mechanical Engineer's Pocket Book," Kent; or to other similar works.

The following, while in no sense intended to take the place of the study just suggested, may be of value in connection therewith.

Let Figs. 1 and 2 represent, respectively, an elevation and a cross section of a simple beam loaded on its concave and supported on its convex side.

(a) The moment of inertia of any cross section is the sum of the products found by multiplying each elementary area of the cross section of the beam by the square of its distance from the neutral axis of that section. Formulæ for calculating the moments of inertia for ordinary beams of various sections may be found in any engineering handbook. For a ship's section it is necessary to make a calculation which takes into consideration each continuous longitudinal member which acts efficiently in the vessel's girder.

(b) The moment of a force with reference to any given point is the product of that force by the perpendicular distance from its line of action to the reference point (this is sometimes called statical moment). The algebraic sum of the moments of all the external forces either to the right or left of a given section in a beam is known as the bending moment at that section. Formulæ for bending moments in simple beams for various ordinary distributions of loads are also given in handbooks, but bending moments in a ship must be estimated as described later.

(c) The external loads, or forces, on each side of any cross section of the beam are maintained in equilibrium by the internal stresses generated at that section, see OO_1. It results, accordingly, that the material in the upper portion, AA_1, of the beam experiences a shortening tendency, termed compression, while the material in the lower portion, BB_1, experiences a lengthening tendency, termed tension.

(d) There exists a surface, NN_1, which divides the portion under compression from that under tension. This is termed the neutral surface or axis because it is subjected to neither tension nor compression and consequently is unchanged in length.

(e) The sum of the bending moments produced by the external loads on either side of any section is resisted by the sum of the moments of the internal stresses, both tensile and compressive. This resisting moment equals the bending moment and is expressed by the equation, $\frac{pI}{y} = M$.

(f) The resisting shear is the algebraic sum of all the vertical components of the internal stresses at any section of the beam.

(g) The strength of a beam subjected to a bending moment is determined by its section modulus; that is, the ratio of its moment of inertia to the distance of its outermost fiber from its neutral axis, viz., $\frac{I}{y}$.

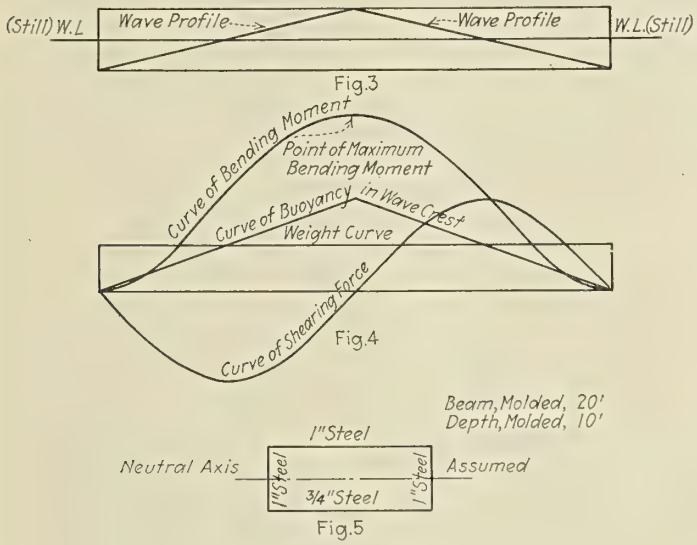
(h) The neutral axis passes through the center of gravity of the cross section.

(i) The stresses, either tensile or compressive, increase directly with the distance y of a point in the cross section from the neutral axis. Hence, in the case shown, the greatest compressive stress occurs at the upper surface of the beam and the greatest tensile stress at the lower surface.

(j) The resistivity, either tensile or compressive, of a material is usually given in pounds or tons per square inch of cross section; thus, mild steel may be said to have an ultimate or breaking down strength in tension of 60,000 pounds per square inch of cross section. Therefore, mild steel members should be so proportioned that the unit stress to which they are to be subjected under ordinary working conditions will fall well below 60,000 pounds, usually as low as 12,000 or 15,000 pounds.

(k) It is difficult to measure with exactness either the

bending moment or the stresses resulting in a ship at a given time and in a given condition. For the purpose of the strength calculation, then, the ship is assumed to be either on the crest or in the hollow of a trochoidal wave having the same length as that of the ship and a height from trough to crest equal to 1/20 of its length. The bending moment resulting is estimated graphically and the unit stress figured from the formula in question, $p = \frac{M\,y}{I}$, in which M is usually expressed in foot tons, I in square inches times feet squared, y in feet, and p in tons per square inch. The values of p resulting are considered to be relative rather than absolute. That is, if we are dealing with a destroyer design, and the proposed scantlings as laid out on the midship section work out to a value of 8.5 tons per square inch for p, because many other destroyers with similar values of p have been satisfactory in service, we are justified in accepting the scantlings. If the value of p for the conditions assumed



Figs. 3, 4 and 5

worked out 10.5, more material should be used. Such material would probably be best added in stringer, sheer, keel and garboard strakes because farthest from the neutral axis.

(l) In order that vessels may be comparable as described above, the type, arrangement, and condition of loading and character of strength, members must be similar.

Let us illustrate the application of the foregoing by a simple case. Assume—

(a) That we have a scow of rectangular form as shown in Figs. 3 and 5.

(b) That this scow is supported in a wave crest whose profile is triangular in shape and whose length and height (from trough to crest) are the length and depth, respectively, of the scow.

(c) That the material of which the scow is constructed is so distributed as to give her a constant weight per linear foot throughout her entire length, and that this weight is such that the draft in still water is half the depth of the scow.

Then, for the condition shown, the scow being empty—

(a) The weight curve is rectangular, Fig. 4.

(b) The buoyancy in the wave crest is triangular in shape and symmetrical about mid-length.

(c) The difference between the weight and buoyancy curves at any point represents the force acting on the scow's strength girder at that point.

(d) The difference in areas under weight and buoyancy curves on either side of a fixed point is the shear at that point. A curve may be drawn through the values of shear, plotted at close intervals throughout the scow's length. This curve is known as the shearing force, or simply shear curve. The method of its derivation is termed the integration of the load curve, though this curve need not actually be drawn.

(e) The curve of bending moment is obtained by integrating the curve of shears. Its greatest height gives the maximum bending moment, M (see Fig. 4).

(f) The moment of inertia of the vessel's cross section (see Fig. 5) is obtained as follows, the deck being assumed to be without opening and both deck and bottom properly supported so as to work efficiently in longitudinal strength.

Item	Area in Square Inches	Lever in Feet	Moment About Neutral Axis	Lever in Feet	Uncorrected Moment Inertia	Correction, $1/12\ A\ h^2$	Corrected Moment of Inertia
ABOVE NEUTRAL AXIS							
½ deck	121	5.04	610	5.04	3080	0	3080
½ side plating.....	60	2.5	150	2.5	375	31	406
	181		760		3455		3486
BELOW NEUTRAL AXIS							
½ bottom plating..	90.6	5.03	456	5.03	2300	6	2300
½ side plating.....	60	2.5	150	2.5	375	31	406
	150.6		606		2675		2706
Summation	331.6		154				6192

The difference in the moments of the material above and below the assumed neutral axis, viz., 760 — 606 = 154, indicates an error in the assumed location of the neutral axis. Its actual position is $5 + \left(\frac{154}{331.6}\right) = 5.46$ feet above the upper surface of bottom plating. The corrected value of the moment of inertia about the proper neutral axis is $6192 - (.46)^2\ 331.6 = 6121$.

The total moment of inertia for both sides $= 2 \times 6121 = 12242$ square inches by feet squared.

(g) Assume now that the value of the maximum bending moment as read from the curve, Fig. 4, is 12,000 foot tons. The distance y to the most strained fiber in the deck is $5.08 - .46 = 4.62$ and to the most strained fiber in the keel $5.06 + .46 = 5.52$.

Then the maximum tensile stress in the deck,

$$p = \frac{12{,}000 \times 4.62}{12{,}242} = 4.52 \text{ tons per square inch,}$$

and the maximum compressive stress in the keel,

$$p_1 = \frac{12{,}000 \times 5.52}{12{,}242} = 5.42 \text{ tons per square inch.}$$

If now this were a riveted structure, allowance should be made for rivet holes in the tension members. This may be taken as 20 percent for the structure of an ordinary vessel. It is usually assumed that the rivets completely fill the holes so that in the compression members no allowance is made.

Spring Meeting of Naval Architects' Society

A special meeting of the Society of Naval Architects and Marine Engineers will be held in assembly room No. 1 of the Engineering Societies Building, 29 West 39th Street, New York, on Thursday evening, May 26 at 8 P. M. Papers will be read by John F. Metten, chief engineer, The William Cramp & Sons Ship & Engine Building Company, and J. C. Shaw on "The Internal Combustion Engine as Applied to Marine Propulsion," and by Robert Warriner, chief engineer of the Bethlehem Shipbuilding Corporation, Ltd., on "Reduction Gears for Ship Propulsion."

PERSONAL MENTION

Nathaniel Green Herreshoff, prominent naval architect and engineer, has been elected an honorary member of the American Society of Mechanical Engineers. The honor will probably be conferred upon Mr. Herreshoff at the spring meeting of the Society.

R. H. M. Robinson has been named by the Harriman interests to serve as president of the American Ship & Commerce Corporation, New York, and will hold the same position for the subsidiary navigation company. Mr. Robinson has been associated with W. A. Harriman for several years and has been president of the Merchant Shipbuilding Corporation at the Chester plant and agent for the Emergency Fleet Corporation at the Bristol yard.

Captain William P. Durtnall, consulting engineer, was born at Herne Bay, Kent, 1872. He received his education in the public schools of this place and later completed his training in the shops of the Maxim Electric Company, London. Until 1905 he held various positions in connection with the operation and maintenance of mechanical and electrical plants. At this time he commenced a thorough study of naval architecture and marine engineering and soon after developed the system of electrical power transmission for ships, known as the thermo electric ship propulsion system. The principles of this system have been applied to motor omnibus transmission and to railway locomotives. In 1907 he was elected a member of the Institution of Automobile Engineers, and in 1908 a member of the Institution of Marine Engineers. In 1912 he was elected a member of the North East Coast Institution of Engineers and Shipbuilders. In this year he carried out a complete series of tests on the auxiliary machinery of cargo vessels in Italy and demonstrated the possibility of adapting the internal combustion-electric drive to ships. He spent part of this period in developing internal combustion engines in connection with locomotive practice. During the early part of the war he was engaged in the design and erection of a gun-cotton plant near London, and later was commissioned as a lieutenant in the navy and assigned to H. M. S. *Vernon,* on which ship he conducted tests on signalling apparatus. Later in the war he served with the Royal Air Force as staff captain, carrying out tests on prime movers. Since June, 1920, he has been on the consulting staff of Messrs. R. & W. Hawthorne, Leslie & Company, Ltd., and has been engaged in the development of his various inventions in connection with hydro-electric and internal combustion locomotives.

Capt. Wm. P. Durtnall

Frederick W. Baker, former assistant superintendent of construction at the Bath Iron Works, Bath, Me., has been appointed superintendent of construction to succeed the late John McInnes, who died January 22. Mr. Baker is a graduate of the Massachusetts Institute of Technology and studied naval architecture at the University of Glasgow; he was formerly connected with William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., with the New York Shipbuilding Corporation, Camden, N. J., and the Newport News Shipbuilding & Dry Dock Company, Newport News, Va.

OBITUARY

Lester Gray French, for thirteen years editor of *Mechanical Engineering,* the journal of the *American Society of Mechanical Engineers,* died on April 18, at the French Hospital, New York City, from septic poisoning following an operation. Mr. French was a graduate of the Massachusetts Institute of Technology. From 1897 until 1906, he was editor-in-chief of *Machinery.* In 1908 he became editor of the publications of the *American Society of Mechanical Engineers,* and in recent years acted also as assistant secretary of the society.

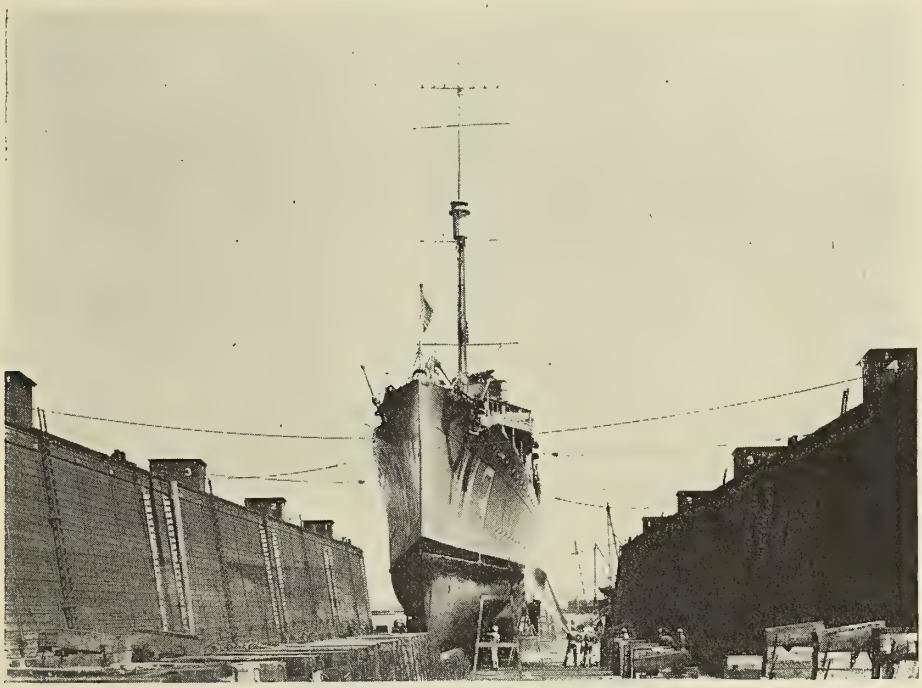
William Dunderdale Forbes, well known in this country and abroad as a consulting engineer, inventor, manufacturer and writer on engineering subjects, died at his home in New Orleans, La., on February 17. Born in Perth Amboy, N. J., Mr. Forbes was educated abroad, and while a student in France served in the Franco-Prussian war as a franc-tireur in the French Army. Before returning to this country he worked with the famous gunsmiths of Switzerland and for a time was on the editorial staff of *Engineering* of London. Upon returning from Europe in 1872, Mr. Forbes began his professional career with the Delamater Iron Works, at that time located on West 11th street, New York City. Following this, he became engineer of the Gould Sprinkler Company, 237 Broadway, New York. He then spent two years in Kempton, Jamaica, as operating engineer for the Watson Sugar Plantation Company, and in 1878 was appointed by Governor Palmer of Colorado as chief engineer of the Gunnison Division of the Denver and Rio Grande Railroad Company with headquarters at Gunnison, Colo. Returning East after two years, be became superintendent of the Eaton, Cole & Burnham Manufacturing Comany, Bridgeport, Conn. At this time he invented the Forbes patent die stock and, forming a partnership with Roderick P. Curtis of Bridgeport, took up the manufacture of this specialty, selling his interest to the Curtis family in 1888. As Mr. Forbes was chiefly interested in the development and manufacture of high speed marine engines and other marine machinery, he came to New York and, entering into partnership with the late Col. E. A. Stevens, established the W. D. Forbes Company in Hoboken, N. J., for the manufacture of marine engines and ice machines for the Government and for owners of private yachts. For sixteen years this plant, known to many as the "gun shop" on account of Mr. Forbes' interest in the development of rapid fire machine guns, was in active operation in Hoboken, after which it was moved to New London, Conn., where later, owing to unfavorable business conditions, the business was discontinued. Seven years ago, Mr. Forbes was stricken with brain fever, resulting in total blindness. During the last years of his life, although deprived of sight, Mr. Forbes continued his professional activities in the design and development of mechanical devices, including a successful automatic rifle, and in contributing to the engineering press, many of his articles appearing in Marine Engineering. For many years Mr. Forbes was an active member of the Society of Naval Architects and Marine Engineers, serving several terms as a member of the Council. He was also a member of the Engineers' Club of New York. Apart from his professional career, his interests were many and varied. For nine years he was a member of the Board of Education of New Jersey, and for several years was in charge of the colored school at Bordentown, N. J. He is survived by a wife, a daughter and a son, who is State Forester of Louisiana. To those who were privileged to know and work with Mr. Forbes, his life will always be an inspiration, not only because of his ability and achievements, but also because of the brave and generous spirit which marked his cheerful and helpful association with his fellow men.

Shipbuilding and General Marine News

Contracts for New Ships — Shipyard Improvements — Engineering Projects—Improved Appliances—Personal Items

RECONDITIONING CONTRACTS VALUED AT MILLIONS WERE PLACED DURING PAST MONTH

Los Angeles Shipbuilding & Dry Dock Company Wins Notable Government Award to Repair Over Ships—Eastern Yards Get Big Contracts—Employment For Many



The Race Horse of the Ocean. The U. S. Destroyer *Rathburne* in the Dry Dock of the Los Angeles Shipbuilding & Dry Dock Company

Ship reconditioning contracts involving millions of dollars and which will afford employment to many hundreds of workmen of innumerable trades—these are two of the principal outstanding features of the situation in American shipyards during the past month. Although some yards are idle, latest reports received by MARINE ENGINEERING indicate a pronounced improvement over the month previous.

Outside of New York probably the most interesting contract is that drawn and approved at Washington, D. C., by the terms of which the destroyers and other Government craft of the Pacific Fleet, approximating over 100 vessels, are to be sent as need arises to the plant of the Los Angeles Shipbuilding & Dry Dock Company, in the west basin of Los Angeles harbor, for dry docking and repairs. This contract is taken to mean a steady and substantial outlay by the Navy Department, which in turn reflects credit upon the shipyard and much brighter prospects for its employes and in this connection is believed to be of far-reaching import to the harbor and city and the entire community.

In February, last, Rear Admiral Welles, Captain T. S. Jewett and Captain Chauncey Shackford made a very thorough inspection of the dry docking and repair facilities of the Los Angeles Shipbuilding & Dry Dock Company's plant, at the close of which Admiral Welles spoke very highly of the scope of facilities and the complete equipment which the local yard provided, saying in fact, "I am greatly impressed with the shipbuilding and dry docking facilities here. I had no idea that there was such a shipyard here which could build six large steamers at one time. I find the facilities of dry docking at the Los Angeles Shipbuilding & Dry Dock Company excellent and fully meeting the requirements."

Following the Admiral's inspection of the facilities of the yard, a further test was made by the department sending first a mine layer, the U. S. S. *Gannet*, for dry docking, hull attention and minor repairs and later the destroyer *Rathburne* for similar treatment. The eminently satisfactory results of these practical tests have apparently presented the final argument for the signing of the definite contract between the Navy Department and the officials of the shipyard under the terms of which a steady succession of destroyers and other Government craft will be sent to its plant for such treatment as they require. It is understood that because of the congested conditions at the Mare Island Navy Yard, a large number of the vessels of the Pacific Fleet have been unable to receive the dry docking and repair attention required. In the majority of instances, they are expected to remain on the dry dock about 48 hours each for thorough hull cleaning and painting. Some, however, will require a longer time for other repairs to be carried out.

In addition to the upwards of 100 destroyers of the Pacific Fleet under Admiral Welles' command based on Los Angeles and San Diego, there are a number of Government colliers, mine layers, tugs and several cruisers for which the dry docking and other repair facilities of the Los Angeles Shipbuilding & Dry Dock Company are fully adequate.

Contracts of note placed with yards in and around New York during April include the *George Washington*, at the Tietjen & Lang yard; the *America*, Morse Dry Dock & Repair Company; the *Momus*, the Tebo Yacht & Basin Company; the *Coppename*, at the W. & A. Fletcher Company, this ship being the third of three similar jobs.

It is also reported that David Rodgers, of Seattle, Wash., who became prominent as a shipbuilder when Seattle was making records during the war, has purchased a floating dry dock and equipment of the old Seattle Dry Dock Company for the establishment of a large marine repair plant.

Rinek Cordage Company Gets Shipping Board Contract

The Rinek Cordage Company, Easton, Pa., were the successful bidders recently for the rope requirements for the United States Shipping Board, beginning March 1st. The company has opened a warehouse and permanent offices in New York City, the offices being at 149 Broadway. John W. Miller is sales manager.

"Imperator's" Name Changed

The Cunard Steamship Company notify that, in consequence of their desire to bring the name into harmony with other vessels of the company's fleet, they have applied to the Board of Trade for permission to change the name of the *Imperator* to *Berengaria*. They have also asked permission to have Liverpool substituted for London as the vessel's port of registry.

NEW FIREBOAT

Commissioner Whalen Drives First Rivet in $222,000 Job

On March 31st the keel was laid for a new steel fireboat which the Standard Shipbuilding Corporation, of Shooters Island, New York, is building for the fire department of the City of New York. The first rivet in the keel of the new fire fighter was driven by Grover A. Whalen, Commissioner of Plant and Structures of the City of New York.

The new fireboat, which will cost $222,000, will be similar to the *William J. Gaynor*, 121 feet long, 27 feet beam, 14 feet 9 inches depth, and will have a speed of 12 knots. This new fire fighter will be equipped with the latest fire fighting appliances, and, when completed, will supplant the *William J. Gaynor* at Brooklyn, while the latter will be transferred to Staten Island to protect the new pier developments.

March Construction

The Bureau of Navigation, Department of Commerce, Washington, D. C., reports 83 sailing, steam, gas and unrigged vessels of 145,852 gross tons built in the United States and officially numbered during the month of March, 1921. Of the total, 8 vessels of 5,029 gross tons were for the United States Shipping Board and 10 of these ships were steel tankers. Three vessels with a total of 9,012 tons were built in the United States for foreign owners during the month of February and 20 vessels of 8,375 gross tons were reported as transferred to foreign flags during the month of March.

Civil Service Examinations

Applications are being received at the Bureau of Yards and Docks, Navy Department, Washington, D. C., to fill vacancies in the commissioned grade of Assistant Civil Engineer, Corps of Civil Engineers, U. S. Navy, with rank of Lieutenant (junior grade). The pay and allowances at entrance are approximately $3,200 per annum, with increase up to $9,600, depending upon promotions in rank and length of service. The candidate must be an American citizen between the ages of 22 and 30 years on August 1, 1921; must have received a degree in engineering; must have had not less than 20 months practical professional experience since graduation, and must be of good moral character and repute. The preliminary examination to determine general fitness will be based on papers submitted by the candidates, reaching the Board on or before May 16, 1921, covering college record, testimonials, references and professional experience.

The United States Civil Service Commission has announced examinations to be held on May 25 and 26, and July 6 and 7 to fill a number of existing vacancies in positions of junior engineer and deck officer, United States Coast and Geodetic Survey. The entrance salary is $2,000 a year.

TANKER LAUNCHED

Union Shipbuilding Company Completes Another Oil Carrier

The bulk oil tanker *Gulfprince*, latest addition to the fleet of the Gulf Refining Company, was launched April 2 at the yard of Union Shipbuilding Co., Curtis Bay, Baltimore, Md. A duplicate, the *Gulfking*, was launched during December. The big tanker was practically complete when launched, boilers and engines having been installed while on the ways.

They are single screw ships 436 feet 1 inch length overall, 419 feet 3 inches length between perpendicular, 56 feet 3 inches beam, 33 feet 4 inches depth to upper deck, and 9,970 tons deadweight. The vessels are of the shelter deck type, machinery and quarters aft, bridge-house amidships, with two pole masts. They are built to Lloyds, 100 A-1, Special Survey on the longitudinal system of framing.

The propelling unit consists of a triple expansion engine 27 inches by 45 inches by 75 inches and 51 inches stroke, which gives a loaded sea-speed of 11½ knots. Steam at 195 pounds working pressure is generated by three single-ended Scotch boilers, 15 feet 10 inches diameter by 11 feet 4 inches long, having three 46 inches Morrison corrugated furnaces. The Howden System of forced draft is used.

New Pump Foundry

It is announced at Montreal that Messrs. G. & J. Weir (Canada), Ltd., are starting on the construction of a foundry at Ville La Salle, near Montreal, for the manufacture of Weir pumps of all kinds, oil fuel pressure pumps and oil fuel transfer pumps, service pumps for ballast, fresh water and general purposes, turbine-driven circulating pumps, dual air pumps, direct-acting feed pumps, turbo feed pumps, etc. It is proposed to start with a staff of about fifty molders and the necessary complement of other workers, with the expectation that the industry will rapidly grow with the development of the port.

SHIPS UNDER CONSTRUCTION IN VARIOUS YARDS FOR UNITED STATES NAVY

Vessels under construction for the United States Navy, their degree of completion and the probable dates of completion as reported March 31, 1921, are announced by the Bureau of Construction and Repair, Washington, D. C., as follows:

Type Number and Name	Contractor	% of Completion Apr. 1, 1921 Total	% of Completion Mar. 1, 1921 Total	Probable Date of Com'tion
BATTLESHIPS (BB)				
44 *California*	Mare Island Navy Yard	96.1	95.8	10- 1-21
45 *Colorado**	New York S. B. Corp.	69.3	68.	6- -22
46 *Maryland*	New. News S.B. & D.D. Co.	96.8	95.	7- -21
47 *Washington*	New York S. B. Corp.	61.2	59.5	4- -23
48 *West Virginia*	New. News S.B. & D.D. Co.	49.5	47.	10- -22
49 *South Dakota*	New York Navy Yard	26.7	26.	
50 *Indiana*	New York Navy Yard	23.1	21.4	
51 *Montana*	Mare Island Navy Yard	18.	17.4	
52 *North Carolina*	Norfolk Navy Yard	27.4	24.1	
53 *Iowa*	New. News S.B. & D.D. Co.	16.1	14.1	
54 *Massachusetts*	Beth. S.B. Crp. (Fore River)	2.5	2.	11- -22
BATTLE CRUISERS (CC)				
1 *Lexington*	Beth. S.B. Crp. (Fore River)	13.8	10.6	9- -23
2 *Constellation*	New. News S.B. & D.D. Co.	7.9	6.5	
3 *Saratoga*	New York S. B. Corp.	18.1	16.	12- -23
4 *Ranger*	New. News S.B. & D.D. Co.	1.2	1.1	
5 *Constitution*	Philadelphia Navy Yard	4.3	3.	
6 *United States*	Philadelphia Navy Yard	4.3	3.	
SCOUT CRUISERS (LIGHT CRUISERS, CL)				
4 *Omaha*	Todd D. D. & Const. Corp.	90.	88.4	12- -21
5 *Milwaukee*	Todd D. D. & Const. Corp.	84.7	81.6	3- -22
6 *Cincinnati*	Todd D. D. & Const. Corp.	80.6	73.4	5- -22
7 *Raleigh*	Beth. S.B. Crp. (Fore River)	51.4	47.5	3- -22
8 *Detroit*	Beth. S.B. Crp. (Fore River)	51.2	47.4	4- -22
9 *Richmond*	Wm. Cramp & Sons Co.	62.	60.	2-15-22
10 *Concord*	Wm. Cramp & Sons Co.	60.	59.	4- 1-22
11 *Trenton*	Wm. Cramp & Sons Co.	41.	40.	6- 1-22
12 *Marblehead*	Wm. Cramp & Sons Co.	39.	38.	7- 1-22
13 *Memphis*	Wm. Cramp & Sons Co.	32.	31.	9- 1-22
AUXILIARIES				
Fuel ship No 18. *Pecos* (oiler AO 6)	Boston Navy Yard	75.5	67.4	11- -21
†Amm. ship No. 2, *Nitro* (AE 2)	Puget Sound Navy Yard	99.9	99.9	4-16-21
Repair ship No. 1, *Medusa* (AR 1)	Puget Sound Navy Yard	58.	55.5	2-28-22
Dest. tender No. 3, *Dobbin* (AD 3)	Philadelphia Navy Yard	52.3	50.3	3- 1-22
Dest. tender No. 4, *Whitney* (AD 4)	Boston Navy Yard	19.5	17.6	10- -22
Sub. tender No. 3, *Holland* (AS 3)	Puget Sound Navy Yard	14.	9.5	
Aircraft tender, *Wright* (AZ 1)	Tietjen & Lang	57.	48.	7-15-21
DESTROYERS				
135 *Tillman*	Charleston Navy Yard	99.	98.9	4-30-21
230 *Paul Jones*	Wm. Cramp & Sons Co.	98.	95.	4-18-21
249 *Hopkins*	New York S. B. Corp.		99.	‡3-21-21
250 *Lawrence*	New York S. B. Corp.	99.7	97.3	4-15-21
322 *Mervine*	Beth. S. B. Crp. (San Fran.)		100.	‡3- 1-21
323 *Chase*	Beth. S. B. Crp. (San Fran.)		95.1	‡3-10-21
324 *Robert Smith*	Beth. S. B. Crp. (San Fran.)		90.2	‡3-17-21
325 *Mullany*	Beth. S. B. Crp. (San Fran.)		86.9	‡3-29-21
326 *Coghlan*	Beth. S. B. Crp. (San Fran.)		82.9	‡3-31-21
327 *Preston*	Beth. S. B. Crp. (San Fran.)	96.2	80.	4-13-21
328 *Lamson*	Beth. S. B. Crp. (San Fran.)	90.6	80.7	4-18-21
330 *Hull*	Beth. S. B. Crp. (San Fran.)	86.6	78.3	4-20-21
331 *MacDonough*	Beth. S. B. Crp. (San Fran.)	83.2	78.3	4-27-21
332 *Farenholt*	Beth. S. B. Crp. (San Fran.)	78.2	74.1	5- 4-21
333 *Sumner*	Beth. S. B. Crp. (San Fran.)	79.5	76.6	5-10-21
334 *Corry*	Beth. S. B. Crp. (San Fran.)	73.	60.8	5-20-21
335 *Melvin*	Beth. S. B. Crp. (San Fran.)	63.9	55.4	5-31-21
338 *Wasmuth*	Mare Island Navy Yard	97.3	97.1	
339 *Trevor*	Mare Island Navy Yard	94.4	94.2	
340 *Perry*	Mare Island Navy Yard	58.1	56.7	
341 *Decatur*	Mare Island Navy Yard	54.2	52.8	

Destroyers authorized but not under construction or contract: (12) Nos 348 to 359, inclusive.

(*Contined on next page*)

	PATROL VESSELS			
Gunboat No. 22, *Tulsa* (PG 22)	Charleston Navy Yard	59.8	55.	12-30-21
Authorized but not under construction or contract: (1) Transport No. 2.				
	SUBMARINES			
115 S-10	Portsmouth, N. H., Navy Yd	90.3	88.7	
116 S-11	Portsmouth, N. H., Navy Yd	85.7	84.6	
117 S-12	Portsmouth, N. H., Navy Yd	75.4	74.4	
118 S-13	Portsmouth, N. H., Navy Yd	65.3	59.2	
123 S-18	Elec. Boat Co. (Quincy)	97.	97.	
124 S-19	Elec. Boat Co. (Quincy)	96.5	96.5	
125 S-20	Elec. Boat Co. (Quincy)	98.5	98.5	
126 S-21	Elec. Boat Co. (Quincy)	94.9	94.9	
127 S-22	Elec. Boat Co. (Quincy)	95.8	95.8	
128 S-23	Elec. Boat Co. (Quincy)	94.	94.	
129 S-24	Elec. Boat Co. (Quincy)	93.	92.1	
130 S-25	Elec. Boat Co. (Quincy)	93.5	93.	
131 S-26	Elec. Boat Co. (Quincy)	92.4	91.4	
132 S-27	Elec. Boat Co. (Quincy)	91.	89.7	
133 S-28	Elec. Boat Co. (Quincy)	91.6	89.7	
134 S-29	Elec. Boat Co. (Quincy)	90.5	88.8	
136 S-31	Elec. Boat Co. (San Fran.)	97.5	97.5	
137 S-32	Elec. Boat Co. (San Fran.)	95.1	94.4	
138 S-33	Elec. Boat Co. (San Fran.)	99.2	99.2	
139 S-34	Elec. Boat Co. (San Fran.)	93.8	92.7	
140 S-35	Elec. Boat Co. (San Fran.)	92.9	87.5	
141 S-36	Elec. Boat Co. (San Fran.)	83.7	83.4	
142 S-37	Elec. Boat Co. (San Fran.)	79.9	76.8	
143 S-38	Elec. Boat Co. (San Fran.)	71.4	71.1	
144 S-39	Elec. Boat Co. (San Fran.)	67.2	67.2	
145 S-40	Elec. Boat Co. (San Fran.)	71.6	71.6	
146 S-41	Elec. Boat Co. (San Fran.)	72.9	71.7	
153 S-42	Elec. Boat Co. (Quincy)	56.8	51.7	1- -22
154 S-43	Elec. Boat Co. (Quincy)	56.9	52.8	1- -22
155 S-44	Elec. Boat Co. (Quincy)	54.9	51.	2- -22
156 S-45	Elec. Boat Co. (Quincy)	56.2	52.2	3- -22
157 S-46	Elec. Boat Co. (Quincy)	54.4	50.8	4- -22
158 S-47	Elec. Boat Co. (Quincy)	54.4	50.8	4- -22
159 S-48	Lake T. B. Co. (Bridgeport)	85.4	81.5	8- 1-21
160 S-49	Lake T. B. Co. (Bridgeport)	76.8	69.3	8- 1-21
161 S-50	Lake T. B. Co. (Bridgeport)	67.8	63.2	9- 1-21
162 S-51	Lake T. B. Co. (Bridgeport)	64.7	62.6	10- 1-21
	FLEET SUBMARINES (SF)			
60 T-2 (SF 2)	Elec. Boat Co. (Quincy)	98.7	98.7	5- 1-21
163 V-1 (SF 4)	Portsmouth, N. H., Navy Yd			
164 V-2 (SF 5)	Portsmouth, N. H., Navy Yd			
165 V-3 (SF 6)	Portsmouth, N. H., Navy Yd			

NOTE: Submarines authorized but not under construction or contract: Fleet submarines (6), Nos. 166 to 171; Neff submarine (1), No. 108.

* Battleship No. 45—launched 3-22-21.
† Ammunition ship No. 2—commissioned 4-1-21.
‡ Delivered.

CHESTER, PA., SHIPYARD TO ENTER GENERAL ENGINEERING AND CONSTRUCTION FIELDS

Merchant Shipbuilding Corporation Makes Announcement of Expansion Into New Lines Which May Provide Employment for Hundreds of Additional Men

The Merchant Shipbuilding Corporation, which operates a modern $6,500,000 plant covering fifty acres at Chester, Pa., has decided to immediately branch out in general engineering lines, embracing steel construction in general, manufacturing and power plant equipment, machinery and machine work, railroad equipment and material, and plate shop work. This will be in addition to the general shipbuilding business now conducted, including ship conversion and repair work.

The yard is adequately equipped for extensive work along these lines, especially in shipbuilding and kindred work. Ships up to 15,000 deadweight ton capacity are now being built. Every facility is available for the conversion of previously built steamships to Diesel motor ships, electric driven or geared turbine drive.

It is also stated from an authoritative source that this corporation will be one of the few in America to be licensed to build Diesel engines. This branch alone would give employment to hundreds of additional men in the Chester Yard.

These new lines recently decided upon by the directors of the Merchant Shipbuilding Corporation hark back to the days when the yard of that pioneer in American shipbuilding, John Roach, was known as the Delaware River Iron Shipbuilding & Engineering Works.

In keeping with the tradition of the Chester Shipyard, which was founded in 1859, the present management is determined to round out its activities and has chosen the above mentioned lines to increase its production capacity.

This expansion is in keeping with the progressive methods of the Harriman interests which control the Chester industry. Already a large organization of specialists in the various new lines of endeavor have been assembled, giving the corporation enviable facilities for handling structural and mechanical engineering projects, as well as marine engineering.

When asked concerning the future of shipyards, J. J. Ackerson, vice-president of the Merchant Shipbuilding Corporation, who is in charge of operations at Chester said:

"The general depression in shipping, and, therefore, in shipbuilding, has forced practically all the shipyards originating during the war to cease all activities, and a great majority of the old yards have suffered a setback from which it will take another period of prosperity to recuperate.

"The consequences of these conditions in regard to unemployment are no longer something which is left to the imagination to realize—they are cold facts."

The general public may be prone to believe that a step such as is now being taken by the Merchant Shipbuilding Corporation, is inspired mainly out of consideration for the money interests behind it. In many if not in most cases, however, it would be infinitely cheaper and easier to close down a plant of this nature until such time as conditions again warrant its reopening, than to enter strange fields during a period of strong competition and general depression. Even with the extensive facilities this yard has at its disposal, the expenditures for remodeling and reorganizing a 100 percent shipbuilding yard into a general manufacturing and industrial concern must necessarily be considerable.

Mr. Ackerson was asked whether or not his company would be able to operate the plant under its new conditions on a comfortable basis, therefore assuring the permanancy of the new ventures. This question brought forth an emphatic "Yes." Mr. Ackerson continued by saying:

"We will do our best to work at a small profit. Any other principle would be unsound from a business standpoint, apart from the fact that we would lay ourselves open to attack for being unfair competitors. However, the small profit which we will be able to add in competition as keen as it is at present will by no means provide an adequate return for the capital invested in the plant, but Mr. Harriman considers it incumbent upon everybody who has means enough for weathering the storm to do their utmost to keep the industrial plants going, both for the sake of American industry and enterprise generally."

MARINE EXHIBIT

New York City to Have First Annual Exhibit of New Association

The first meeting of the executive committee of the newly organized Marine Equipment Association of America was held in the office of Colonel Edward A. Simmons, president, on April 12. It was decided to hold the first annual exhibit in New York City in November of this year, during the week in which the Society of Naval Architects and Marine Engineers will hold its annual meeting.

The following were appointed chairmen of the committees named: W. M. Wampler, Coen Company, exhibits; Frank Hatch, Shepard Electric Crane & Hoist Company, entertainment; J. D. Sarles, Pyle-National Company, enrollment, and W. M. McFarland, Babcock & Wilcox Company, finance. In addition M. L. Katzenstein, of the Worthington Pump & Machinery Corporation, was designated as chairman of a special committee to act in connection with one which it is expected the Society of Naval Architects and Marine Engineers will appoint for joint action in planning activities during the week of the marine show.

CANADIAN CONSTRUCTION

329 Vessels in 1920 With 100,000 Deadweight Tons Coming

Complete returns for 1920 show that the Canadian shipbuilding industry turned out a great deal more tonnage than seemed probable at the end of the year. Statistics just issued by the Department of Marine and Fisheries placed the total gross tonnage built at 204,635 tons, representing 351 vessels of one kind or another.

The vessels built and registered in Canada during 1920 numbered 329, classified as follows: wooden sailing vessels 121, wooden steam vessels 53, wooden gas vessels 119, metal vessels—steam 35, gas 1. In point of gross tonnage the steam metal vessels led with 120,127 tons, followed by wooden sailing vessels, 22,758 tons; steam wooden vessels, 12,829 tons; gas wooden vessels, 3,495 tons, gas metal vessels, 116 tons—total 159,325 gross tons.

The vessels built but not registered in Canada during the year were 22 in number, 13 of them being wooden steam vessels, 9 steel steam vessels and one wooden sailing vessel. The gross tonnage was: steel steam vessels, 31,135 tons; wooden steam vessels, 13,829 tons; wooden sailing vessels, 348 tons.

British Columbia with 138 to her credit led the provinces in the number of vessels turned out, but Quebec, though she is credited with only 96 vessels, led in gross tonnage with 103,339 tons, as compared with British Columbia's 66,561 tons. These figures do not, however, accurately indicate the tonnage actually turned out in these respective provinces, the vessels for the Canadian Mercantile Marine, a number of which were built in British Columbia, having been registered in Quebec, and thus appear in the tonnage credited to that province. Nova Scotia turned out 90 vessels, almost all small. Ontario is credited with but 17 vessels, showing how the industry has fallen off in that province. New Brunswick turned out 5 vessels, Prince Edward Island 4, and Saskatchewan 1. Alberta and Manitoba do not appear at all in these returns.

The prospects for the present year are admittedly not as good. There are, however, fifteen vessels for the Mercantile Marine still to be delivered, these representing about 100,000 tons deadweight. Some yards are also building vessels on foreign account.

At the 31st of December, 1920, there were 7,906 vessels of all kinds on the Canadian register, of which 3,623 were sailing and 4,281 operated by steam. The gross tonnage of sailing vessels was 505,630, and of steam, 1,105,010 tons, making a total tonnage of 1,610,640 gross, and 1,151,880 net.

Port Authorities' Convention

The tenth annual convention of the American Association of Port Authorities is to be held in Seattle, October 11, 12, 13 and 14. The association comprises all of the organized ports in the United States and Canada. Port authorities are planning to entertain 1,000 delegates.

New Fruit Line in Prospect

Establishment of a line of fruit cargo steamers between Seattle and European ports is in prospect. Nine 15,000-ton steamships, each equipped with 3,000 tons of refrigerated space, will be placed on this route by the Royal Mail Steam Packet Company, according to the information. The fleet of steamers is said to be nearing completion in the Clyde shipyards and the first is scheduled to leave England in May.

Steamer Kathyrn Luckenbach Gets Record Service at Los Angeles

As an example of service particularly appreciated by ship owners, a contract completed by the Los Angeles Shipbuilding & Dry Dock Company on the *Kathryn Luckenbach,* of the Luckenbach Steamship Company, April 2, is worthy of note. The big freighter, arriving with cargo at San Pedro, required some boiler and other repairs and, thanks to the enterprise, equipment and resources of the Los Angeles Shipbuilding & Dry Dock Company, she had 132 tubes replaced in her four boilers, her steering engine and tiller motor repaired, two main brasses bored and rebabbitted and other minor repairs effected during the 48 hours which she lay discharging cargo at her wharf at the Outer Harbor, San Pedro.

Not only was this work done without the ship losing an hour of running time, but by attending to one boiler at a time the shipbuilding company enabled the ship to keep up steam needed for unloading, thus not delaying her at the dock even longer than she would ordinarily have stayed. Shipping men on the San Pedro waterfront claim that it is this type of efficient and prompt service which will prove a big factor in building the business of the port of Los Angeles.

Ship Damaged By Fire

A fire broke out recently on board the 11,000 ton *Grampian,* of the C. P. O. S. line. This vessel has been in the Antwerp Docks undergoing repairs for several weeks. Owing to the vessel being light and consequently very high, difficulty was experienced in extinguishing the fire. The ship is gutted from the master's cabin to the No. 3 hold and the damage is estimated to amount to several million pounds.

BUSINESS NOTES

The Keller Pneumatic Tool Company announces the removal of its Chicago branch to larger and more up-to-date salesrooms and service station. After May 1st this branch will be located on the main floor in the Transportation Building, 624 South Dearborn Street, Chicago, where a complete stock of tools and parts will be maintained. J. C. Campbell is district manager.

Announcement is made of the changing of the general sales offices of the Pollak Steel Company of Cincinnati from 2850-2860 Equitable Building, New York City, to 3115-3116-3117 Equitable Building.

The Engineering Business Exchange, 30 Church Street, New York City, announces the opening of a southeastern branch with Marshall Leighton, consulting engineering of Washington, D. C., as director. The southeastern branch has offices in the McLachlen Building, Washington, D. C., and it will co-operate with the main office in New York City in the conduct of business. Mr. Leighton will have special charge of the territory from Maryland to Alabama inclusive.

The Conveyors Corporation of America, Chicago and New York, announce the appointment of Robert B. M. Wilson as sales engineer of the Chicago district. With him will be associated, as an assistant, E. M. Wolfe. Headquarters will be maintained in the corporation's main office at 326 West Madison Street.

The Airco organization, Air Reduction Sales Company, large manufacturers of Airco oxygen, Airco acetylene and Airco welding and cutting apparatus, will move its executive offices on May 1st from 120 Broadway and 160 Fifth Avenue to 342 Madison Avenue, New York City. Coincident with the announcement of the general office change is another to the effect that the New York district office of Airco after May 1st will be located at the Airco factory, 191 Pacific Avenue, Jersey City, N. J. All correspondence and other communications heretofore directed to the Airco district office at 160 Fifth Avenue, New York, should in the future be sent to 191 Pacific Avenue, Jersey City, N. J.

The E. Horton & Son Company, Windsor Locks, Conn., has purchased the chuck business of the American Company of Hartford, Conn. The American Company has specialized in the three-jaw geared drill chuck known as the Ellison chuck. In adding this line of Ellison drill chucks to its present equipment the Horton Company is enabled to manufacture a drill chuck of every standard including the two-jaw and three-jaw geared chuck and the hand operated self-tightening chuck, making in addition to these a complete line of lathe chucks and face plate jaws.

The International Pulverized Fuel Corporation announces the location of their general office in the National City Building, 17 East 42nd Street, New York City.

Announcement is made by the Superheater Company that on May 1st its general offices will be moved from 30 Church Street to 17 East 42nd Street, New York City.

The Hooven, Owens, Rentschler Company, Hamilton, Ohio, announce the appointment of Mr. Ross L. Fryer, Albee building, Washington, D. C., as their agent in the District of Columbia territory.

Gerard H. Rittenhouse, of Philadelphia, Pa., has severed his connection with United Cork Company, of New York.

Announcement is made that H. M. Hedges has rejoined the Moore & McCormack Company's India service, and that M. S. Ulman is on the staff of the Atlantic, Gulf & Mediterranean Steamship Corporation, New York.

Marine Construction News of the Month

Ship Contracts—New Ship Concerns and Shipyard Improvements—Terminal Projects—Government Contracts

SHIPS AND SHIPBUILDING

Tanker Repairs, Mobile, Ala.—The Gulf Refining Company's steam tanker Winifred will be put into drydock at the Alabama Dry Dock & Shipbuilding Company's plant for repairs.

Steamships Wanted—A company in Australia is reported to be desirous of receiving quotations on six steamships of from 4,000 to 5,000 gross tons, of a type suitable for Australian overseas and coastwise general cargo service.

To Lay Keels, Oakland, Cal.—Five vessels are on the ways of the Union Construction Company and preparations are being made to lay keels for two cutters and an ocean-going tug for the Treasury Department.

Schooner Construction, Victoria, B. C.—The Cholberg Shipyard is reported as actively proceeding with the construction of three of the four wooden schooners being built as lumber carriers with the aid of the Dominion Government.

Barges, Kearny, N. J.—The Federal Shipbuilding Company has just laid the keel for the first of six 350-ton coal barges for the War Department. These barges are being fabricated by the American Bridge Company, Pittsburgh, Pa., and assembled by the Federal Yard.

Car Floats, Newark, N. J.—The Federal Shipbuilding Company has a contract for the construction of three car floats of 1,000 tons each for the New York Dock Company. It is expected that these floats will be ready for delivery next September.

Barges, Pensacola, Fla.—It is reported that the Pensacola Shipbuilding Company has secured contracts for building some additional barges. Although no details have been made public, it is stated that material for about twenty new barges is now being assembled.

Yacht Contract Awarded, Vancouver, B. C.—A contract for building the hull of the Royal Vancouver Yacht Club's Lipton Cup challenger has been awarded to Hoffar Brothers, and work has been started on the boat at the Coal Harbor plant.

Stern-Wheel Boat, Memphis, Tenn.—The Mississippi River Commission, First and Second Districts, Custom House, Memphis, has let a contract for furnishing the stern-wheel steamboat Luther D. Griffith to J. Eichleary, Jr., Twentieth and Wharton streets, Pittsburgh, Pa., at a cost of $41,414.

Car Float, Vancouver, B. C.—It is reported that the Harbor Commissioners are asking tenders for the construction of a car float for operation between Vancouver and North Vancouver. It is said that the float, which is to be of wood, and the building of a slip on the north shore, will cost about $200,000.

Barges, New Orleans, La.—The Doullut & Williams Shipbuilding Company will lay keels for the first two of six 9,000-barrel oil barges of steel construction, which will be followed by the laying of other keels as soon as the material can be assembled for erection. Work at the outfitting dock is being pushed with a vim.

Repairing Steamer, Shooters Island, N. Y.—Contract for installation of a Scotch boiler and miscellaneous hull and engine repairs to the steamer Western Union has been awarded to the Standard Shipbuilding Company, Shooters Island, N. Y., on their bid of $18,000 and seventy days. The work is already under way.

Ship to be Repaired, Brooklyn, N. Y.—The Morse Dry Dock & Repair Company has been awarded the contract for repairs to the tank ship, L. J. Drake, of the Standard Oil Company of New Jersey on a bid of $24,000. The work consists of repairs to the turbines, the cargo oil system and oil heating system.

Reconditioning Fireboat, Brooklyn, N. Y.—A contract for reconditioning the fireboat The New Yorker has been awarded by the New York Fire Department to the Tebo Yacht Basin Company on a bid of $13,544. The work is to be done in forty days, and involves considerable minor repairs to the vessel, especially the renewal of a large number of frames.

Electric Drive Installation, Brooklyn, N. Y.—A contract for the installation of electric drive equipment in the steamship Independence has been awarded by the United States Shipping Board to the Tebo Yacht Basin Company, Brooklyn, N. Y., at a price of $60,000. The Independence is the fourth vessel designated for electric drive.

Repairing Steamer, Brooklyn, N. Y.—The contract for repairing the Ocean Line steamer City of Columbus which struck on Lovellis Island recently, has been awarded to the Robins Dry Dock & Repair Company, which was the lowest bidder. The vessel was floated and received some temporary patches to her bottom plates at Fore River.

Pilot Boat, Baltimore, Md.—Bids were opened recently at the office of the Maryland Pilots' Association, foot of Broadway, for the construction of a pilot boat, 145 feet in length and 25 feet beam, to replace the Carmina at the Cape Henry Station. The proposed tender is to be of steel and is to be driven by triple expansion engines.

Machinery Installation Contract, San Francisco, Cal.—The Winton Engine Works and the Westinghouse Electric & Manufacturing Company have been awarded the contract for the machinery to be installed in the two new auto ferries to be built by the Golden Gate Ferry Company according to announcement made by R. Z. Dickie.

Tankers Building at San Pedro, Cal.—According to word received from O. B. Kebel, works manager of the Southwestern Shipbuilding Company, the company's yard is building two 12,000 tankers for the Union Oil Company. It is also announced that the company has secured contracts for three large tankers to be constructed for the Anglo-Saxon Petroleum Company, which will sail under the Dutch flag.

Overhaul Vessel, Baltimore, Md.—Extensive renovations are being made to the steamer Tred Avon of the Maryland, Delaware and Virginia Railroad Company's fleet. The vessel is to be used as an excursion boat this summer and will take the place of the Westmoreland. The vessel has a carrying capacity of about 600. Staterooms are to be torn from the boat in order to provide deck space.

Fuel Scows, Portland, Ore.—The Port Commission has awarded contracts for the construction of four fuel scows, two to be built by the St. Helens Shipbuilding Company, St. Helens, Ore., and two by the Portland Shipbuilding Company, Portland, Ore., for $12,000 each. The Portland Marine Ways & Boat Company was awarded a contract for building one donkey engine scow for $1,460.

Lightships Needed—Surveys made by the lighthouse service show that the wooden vessels owned by the Shipping Board are not suitable for its purpose and accordingly the next Congress will be asked to appropriate $4,000,000 to $5,000,000 for the construction of new lightships, of which approximately seventeen are needed. The $1,000,000 granted by the last Congress is sufficient only for the construction of three.

Steamer Repairs, Brooklyn, N. Y.—The contract for bottom repairs to the steamship Kaduna, of the Elder-Dempster Line of Liverpool, England, which recently went ashore, has been awarded at Halifax, N. S., to James Shewan & Son of Brooklyn. The award was made on competitive bidding of Canadian and New York yards, the Shewan Company bid involving about $150,000. The work will occupy approximately thirty days.

Vessels Building in Canada—Fifteen vessels, representing about 100,000 tons deadweight, are still to be delivered to the mercantile marine, according to statistics issued by the Department of Marine and Fisheries of Canada. Some of the Canadian yards, the report says, are also building vessels on foreign account. Complete Canadian returns for 1920 place the total gross tonnage built at 104,635 tons, representing 351 vessels of various classes.

Steamer Repairs, Shooters Island, N. Y.—A contract for miscellaneous repairs to the Shipping Board steamer Henry Steers has been awarded to the Standard Shipbuilding Corporation, Shooters Island, N. Y., on a bid of $2,400. Other bids included $2,405 by the Morgan Engineering Company; $2,531, by Ira L. Bushey & Son; $2,585, by Ramberg Dry Dock & Repair Company; the highest bid being $3,440 by the Neptune Marine & Boiler Works.

Painting Contract Pending, New York—Bids for the repainting of ten vessels of the New York City Fire Department are expected to be opened within the next month, according to official information obtainined by MARINE ENGINEERING. Nine fireboats and the motor patrol Velox, it was stated, are to be repainted and the work is expected to involve an outlay of approximately $10,000. No definite date for bid openings has yet been set.

Remodel Steamers, Baltimore, Md.—The Ericsson Line steamers Penn and Lord Baltimore, which have been tied up near St. George's for months, are to be remodeled and placed in operation on the route between Philadelphia and Baltimore, via the Chesapeake & Delaware Canal. It is said that the vessels will be cut down, remodeled and re-equipped before they are again placed in service. It is expected that an oil-burning system will be installed in the vessels.

Reconditioning Steamers—Contract for reconditioning the steamship George Washington was awarded to the Tietjen & Lang Dry Dock Company, Hoboken, N. J., on a bid of $838,000 and 110 running days. The Morse Dry Dock & Repair Company, Brooklyn, N. Y., was awarded the contract for reconditioning the America, on a bid of $572,330. Both vessels will be put in the service of the United States Mail Steamship Company when they are completed.

Shipping Board Contracts—Three contracts were recently awarded by the Shipping Board after competitive bidding, as follows: Steamer West Zeda to the Standard Shipbuilding Corporation, $12,845; steamer Western Sea to the New York Harbor Dry Dock Corporation, $4,077; and the West Wind to the Atlantic Basin, $1,352. The work of the West Zeda includes

the installation of Falk gears, repairs to the heating coil, changing coolers and oil pumps, reriveting parts of the hull and other minor work.

Three Bethlehem Yards Busy—Although announcing that the Harlan & Hollingsworth yard at Wilmington, Del., and the Moore marine shops at Elizabeth, N. J., will be shut down shortly as all orders are now being cleaned up, President E. G. Grace, of the Bethlehem Steel Corporation, is credited with the statement that the Company's shipyards at Fore River, Mass., Sparrows Point, Md., and the Union Plant at San Francisco, Cal., are operating at capacity with sufficient orders for the remainder of this year. While he predicted a "lean year" for 1921, he added there were signs of moderate improvement in the steel industry.

Steamers Wanted, Portland, Ore.—A general commission merchant in one of the British West Indies desires to purchase steamers, according to "Commerce," the weekly publication issued by the Portland Chamber of Commerce. One vessel is wanted with passenger and cargo accommodation space, of not more than 12 feet draft when loaded to carry 800 to 1,000 oxen; and one steamer, river boat, from 60 to 70 meters long to carry 200 to 250 oxen on deck, 7 with upper deck accommodations for sixty first class passengers, top from either shed deck, with captain and pilot accommodations, of 8 feet draft when loaded. Prices, full particulars and blue prints are requested. No reference offered. Refer to No. 34,591.

To Recondition Ferryboat, New York—Plans and specifications are in course of preparation for a general reconditioning of the hull and machinery of the steel hull ferryboat Ellis Island of the United States immigrant station, Ellis Island, New York harbor. The Ellis Island is a 160 foot steamer, and although no official figures were obtainable as to the extent of the appropriations by the Department of Labor for this work, it is understood that the specifications will call for virtually a complete renovation of the vessel inside and out. Bids will probably be opened at the office of Frederick A. Wallis, Commissioner of Immigration at Ellis Island, in about two weeks.

Repairing Schooners and Building New Craft, Seattle, Wash.—One of the most active plants on the waterfront is the marine ways of the Elliott Bay Marine Construction Company, C. O. Morrow, general manager, where many units of the local mosquito fleet are being overhauled and repaired for the coming fishing season. The Fanny Dutart, one of the largest schooners of the fleet, is being practically rebuilt, her house, decks and other items are being replaced. Several other vessels, including the Cherry, Elizabeth, and Imperial are also undergoing repairs at the plant. The construction of several small craft is also being undertaken.

Reconditioning Steamer, Hoboken, N. J.—The steamer Coppename, the third of a series of three vessels of the United Fruit Company fleet to undergo general reconditioning under contract with the W. & A. Fletcher Company, Hoboken, has arrived at the company's yards. In addition to dry docking for hull repairs the vessel is to have a new steel stern deck-house, additional cargo space, mast extensions, new rigging throughout, overhaul of all deck machinery, new bridge deck house, new dynamos and pumps, machinery and boiler overhauls. The entire ship will be rewired, new refrigeration coils throughout, and is to be scaled and painted inside and out. There will be complete new galleys and pantries, with various deck renewals. This contract involves close to half a million dollars and about seven weeks' time.

Ferryboats, New York—Plans and specifications will soon be under way for three 225-foot ferryboats for service to Staten Island, construction of which was assured by the recent decision of the Board of Estimate committee on financing budget to make a favorable report to the Board on Plant & Structures. Commissioner Grover A. Whalen's application for $1,560,000 in corporate stock with which to establish a new service to Stapleton. Bids for the construction of these boats will probably be advertised for in July, contract award to be made about August 1, with probable delivery of the boats next March. Tentative plans at present call for the synchronous type of motors, watertube boilers producing 250 pounds working pressure. Curtis turbines, superheaters, and boilers fitted for coal or oil consumption. Of the fund approved, $200,000 will be used for construction of slips and racks at Stapleton, plans for which are now under way.

Electric Equipment for Barges, Duluth, Minn.—The General Electric Company, Schenectady, N. Y., has contracted to supply electric auxiliary equipment for five Diesel-engine barges being built by the McDougall Duluth Shipbuilding Company, Duluth, Minn., for the Erie Canal Transportation Company of New York. The barges are 250 feet long, 36 feet beam and 10 feet draft, each being equipped with a 140-brake horsepower direct reversible Skandia Pacific Diesel engine. The displacement of these barges is 2,150 tons. The electric equipment will consist of three 10-kilowatt, 400 revolutions per minute generators, each driven by a 15-horsepower Diesel engine for auxiliary power and lighting on each barge. There will also be seven electric motors ranging from 10 to 1 horsepower, to be used on pumps, steering gear, etc. The barges will be very thoroughly equipped with electric auxiliaries, as they will have electric hydraulic steering gear, electric anchor windlasses and electric capstan.

SHIPYARDS AND DRYDOCKS

Boat Manufacturing Plant, Lynn, Mass.—The Shawmut Marine Company plans a number of buildings which will comprise a small boat manufacturing plant.

Drydock Equipment, Perth Amboy, N. J.—The Perth Amboy Dry Dock Company, foot of Broad Street, will install equipment at once at its new $10,000 drydock.

To Erect Shipyard, Alberta, Can.—The Albert & Arctic Transportation Company, Fort McMurray, has secured a site and will proceed with the erection of shipyards for the construction of vessels. W. J. West is manager.

Shipyard Leased, Tampa, Fla.—The Tampa Shipbuilding & Engineering Company has leased its yard to the Oscar Daniels Company, thus giving the Daniels Company extensive marine repair facilities.

Marine Railway, Etc., Miami, Fla.—It is reported that A. Pelsan will reconstruct the Pilkington Boat Yards. An additional basin will be dug, a marine railway built, and several hoists, etc., installed.

Repair Plant Sold, New York—The small dry dock and repair plant in New York harbor conducted by Wm. J. Gokey & Company, Inc., has been acquired by the Todd Shipyards Corporation.

Drydock Moorings, Portland, Ore.—The Port of Portland Commission has let a contract to Grant-Smith & Company, Seattle, Wash., for moorings for a new drydock, their bid being the lowest at $87,273.

Marine Repair Plant, Seattle, Wash.—David Rodgers who gained national prominence as a shipbuilder during the war has purchased the floating drydock and equipment of the old Seattle Dry Dock Company for a marine repair plant which is to be expanded.

Reorganizing Company, Channel Dyke, Tex.—The Seaboard Transportation & Shipping Company, which owns a yard at Channel Dyke, Pelican Spit, near Galveston, established in 1917, to build steel and wood vessels, is being reorganized and incorporated, and will soon announce its future plans.

Equipment, Etc., Harrisburg, Tex.—B. H. Elliott, Inc., which was recently incorporated to carry on marine repairs, will erect a 60 by 100 foot mill-construction machine shop for marine repairs, and will install 12 and 25 inch lathes, radial drills, planer and power hacksaw, etc.

Repair and Construction Yard, New Orleans—The Southern Yacht Club has started the organization of a co-operative boat repair and construction yard to be located on the grounds of the club at West End, to take care of the fleet of over 300 power boats which fly the S. Y. C. pennant.

Option on Shipyard Extended, Bristol, Pa.—The Government's option on the Merchant Shipbuilding Corporation's plant at Bristol has been indefinitely extended, pending a decision as to the course to be adopted by the Shipping Board. This option was to have expired recently. Under the agreement with the shipbuilding company, the board can purchase the land on which the plant is situated for $1,300,000. The company has an option to purchase the plant, which was built by the board at a cost of $15,000,000, or the board can remove its materials and equipment. A committee will be appointed by the Shipping Board and the shipbuilding corporation to work out a plan of settlement, it is said.

Yacht Repair Plant, Bridgeport, Conn.—Announcement is made of the formation of the McNab Boat Corporation, incorporated under the laws of the State with a common stock of $150,000. An option on the property of the Black Rock Yacht Club has been obtained, the intention being the establishment of an exclusive yacht repairing and outfitting station with winter storage quarters and club facilities. The new corporation has been formed by Alexander McNab of Bridgeport, inventor of marine appliances and president of the McNab Company. The work of altering the yacht club will commence in a few weeks and the plans call for the construction and installation of a railway drydock by the Crandall Engineering Company of Boston, which is expected to be in place inside of six months. The corporation will enter business as drydock owners, yacht builders and repairers, brokers, designers and consulting engineers. The drydock will be capable of hauling out vessels up to 300 tons and to a length of 125 feet. It is proposed to have the operation of this dock and other machinery effected by electric power.

PORT IMPROVEMENTS

Docks, Brunswick, Ga.—The city contemplates the construction of new docks. Address the Board of Trade.

Wharf, Miami, Fla.—The city contemplates the construction of wharf additions. Address the city engineer.

Dredging, Biloxi, Miss.—The Chamber of Commerce is interested in dredging the local channel.

Bulkhead, Etc., Eustis, Fla.—Bids were received until May 2, 1921, by P. Prioleau, city engineer, for the building of a bulkhead on the lake front.

Terminals, Charleston, S. C.—The city will issue $1,000,000 bonds for the development of the port and terminal facilities. Address Mayor Grace.

Wharf, Gulfport, Miss.—Contract has been let to W. W. Hammons to construct a wharf, at a cost of $12,680.53. H. D. Shaw is city engineer.

River Terminals, Memphis, Tenn.—City has voted bonds amounting to $500,000 for the extension of river terminals. W. B. Fowler is city engineer.

Pier, Gulfport, Fla.—Bonds amounting to $13,000 have been issued for public improvements including pier construction, yacht basin, lighting system, etc. S. J. Webb is town clerk.

Dredging, New York—The Department of Docks and Ferries, Pier A, North River, New York, will soon receive bids for dredging the main channels and building bulkheads in Jamaica Bay involving about $750,000.

Piers, New York—The Department of Docks, Pier A, North River, plans to build six piers along Jamaica Bay, New York, involving the expenditure of about $7,500,000, according to a recent report.

Docks, Dubuque, Iowa—The city plans to build steel and concrete docks, 200 to 300 feet long, involving the expenditure of about $100,000. S. Edwards, United States Engineer Office, is engineer.

Wharves, San Pedro, Cal.—Five new wharves in the inner harbor of San Pedro, Cal., have been recommended by the harbor engineers, and estimates of costs were ordered made by the Commissioner.

Wharf, Boston, Mass.—Messrs. Monks & Johnson, architects and engineers, will receive bids for building a wharf for the William Underwood Company in connection with their new canning factory to be erected.

Dredging Machinery, East Orange, N. J.—R. J. Rudd, 156 N. Grove Street, is reported to be in the market for equipment, including bucket operating derricks, electric hoists, cranes, clam shell buckets, etc.

Wharf, St. Rose, La.—The Petroleum Import & Export Company, a subsidiary of the Carson Petroleum Company, has let contract to N. G. Scott, Hennen Building, New Orleans, for the construction of a 500 by 30 foot wharf.

Docks, Miami, Fla.—Plans for trebling the capacity of the municipal docks and erect an additional 1,000-foot pier costing $400,000 are contemplated by the city. Address the city engineer.

Dredging, Grays Harbor, Wash.—Actual dredging work has been started at Cow Point, the scene of the most extensive operations on the port development programme, and it is expected will take the greater part of the year.

Rebuilding Pier, Galveston, Tex.—The Galveston Wharf Company has advertised for bids for rebuilding Pier 35, which was destroyed by fire last fall. The pier will be 800 feet long and 200 feet wide, and will be reconstructed in ninety days.

Harbor Improvements, Wilmington, Del.—Within the next few weeks $750,000 worth of harbor work is expected to be contracted for at Wilmington, Del., in addition to a considerable sum to be expended for the improvement of the Chesapeake and Delaware Canal.

Ferry Slips—New Hanover County Commissioners let a contract to the Diamond Steamboat & Wrecking Company to construct ferry-slip extensions on the east and west sides of the Cape Fear River. Plans were prepared by the War Department.

Approach and Pier, New York—H. H. Curran, president of the borough of Manhattan, let contract for building an approach and pier at the foot of Dyckman Street and North River, New York, to A. N. Spooner, Pier 11, North River; to cost $38,590.

Dredging, Newark, N. J.—The city has appropriated a sum of more than $1,000,000 for dredging a channel providing for a 30-foot depth at low water, and it is expected that a contract will be awarded for this work within the next two weeks.

Dock and Wharf, Marshfield, Ore.—Construction of the port dock and wharf was ordered by the port of Coos Bay commissioners, and announcement was made of the sale of the remaining portion of the $250,000 bond issue. Major T. F. McGinnis is engineer.

Wharves, Etc., Shiner, Tex.—It is reported that the Shiner Compress Company, of which V. J. Grunder is president, will soon erect wharves 120 feet by 500 feet, and sheds of mill construction, to be built under their own supervision. Two tubular boilers, each 72 inches by 18 feet, will also be installed.

Piers, New York City—According to announcement by Murray Hulbert, Commissioner of Docks, four 150-foot piers will be constructed in the North River beginning at a point near Thirty-sixth Street and extending to a point between 42d and 43d Streets, the piers to be separated by slips 332 feet in width. This will necessitate doing away with the several old piers now in place.

Ship Terminal, Trenton, N. J.—The State Board of Commerce and Navigation has approved the lease of 1,622 lineal feet of bulkheads along the Hudson River to the Luckenbach Terminal Company, of Bulls Ferry, N. J., at an annual rental of $87,500. A great ship terminal will be constructed on the property by this company, which operates steamers in all parts of the world.

Barge Terminal, New York, N. Y.—The State Engineer's office has begun the construction of the barge canal terminal at 137th Street on the Bronx side of the Harlem River. Actual construction of the terminal is the culmination of a plan submitted to the State Canal Board several years ago to improve the freight congestion at the various railroad terminals in the Bronx. The new terminal, which will cost $500,000, will be completed in about three months.

Terminals, Bulls Ferry, N. J.—The Luckenbach Terminals, Inc., organized by the Luckenbach Steamship Company, New York, for the construction of its proposed new freight terminal at Bulls Ferry, on the Hudson River near Edgewater, N. J., is reported to have preliminary plans under way for buildings which will include the installation of cranes, loading and unloading machinery, conveying equipment, etc. It is estimated that the terminal when completed will cost close to $10,000,000.

Piers, Philadelphia, Pa.—Director Sproule of the Department of Wharves, Docks and Ferries issued a license to the city for the construction of the two municipal piers which are to be known as the Girard piers, Nos. 1 and 2 North. The license provided for the building of bulkheads so that when the work is completed there will be a stretch of piers and bulkheads north from the Market Street ferries to pier 9. The cost of construction is about $2,500,000. The piers now occupying this site are being dismantled.

Appropriation for Harbor Improvements—The chief of army engineers has announced that the allotment of funds for Virginia river and harbor projects from the $15,000,000 lump sum appropriation bill passed by the last session of Congress is as follows: Norfolk harbor, $50,000; Rappahanock River, $10,000; Onancock River, $15,000; Pamunkey River, $3,000, which amounts are for maintenance only. There is a large unexpended balance of previous appropriations which is available to continue the improvement of Norfolk, Portsmouth and Newport News harbor and channel.

Harbor Facilities, Quebec, Can.—A sum of $250,000 will be spent this year in improving harbor facilities, and it is expected that a similar amount will be granted by the Dominion government each year until all the proposed improvements are completed, the cost of which is estimated at between $800,000 and $1,000,000. The most important work to be undertaken this year will be the erection of a huge fixed fender to replace the floating fenders at the embankment near Beauport Flats, thus enabling the largest Atlantic liner to dock without the least difficulty, and with a minimum loss of time.

Large Terminal, New Orleans, La.—The Carson Export & Import Company, a branch of the Carson Petroleum Company, has begun work on one of the largest terminals for handling petroleum products in the United States, on a large tract of land situated on the river about sixteen miles north of New Orleans. The wharfage contract has been let to Nat. G. Scott, of New Orleans, while the Lamson Company of Boston, Mass., will build the conveyors. Two warehouses, a pump house, boiler house, power house and shops will be erected. The William Garver Tank Corporation, Chicago, Ill., has the contract for twenty storage tanks. Contracts amounting to about $750,000 have been placed thus far.

Dredging Contracts Pending, New York—Sealed proposals will be received at the United States Engineer Office, Room 710, Army building, 39 Whitehall Street, New York, for dredging in Newtown Creek, New York. The total estimated quantity of material necessary to be removed within the specified limits to complete the work of excavating the channel to a depth of 20 feet at mean low water and ranging in width from 250 feet to 150 feet, is given as 200,000 cubic yards, and the amount available for payment of contractors' estimates is about $200,000. Bids will also be received at the same address until noon on May 12, 1921, for dredging in Gowanus Creek, New York harbor, New York, the total estimated quantity of material necessary to be removed being 123,000 cubic yards, scow measurement, and the amount available for the work is about $36,000.

GOVERNMENT WORK

Air Compressor, Bellevue, D. C.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to install a reciprocating air compressor here.

Harbor Development, Great Lakes, Ill.—Specification 4358, the Bureau of Yards and Docks, Navy Department, Washington, D. C., plans extensive harbor improvements.

Elevated Steel Water Tank, Norfolk, Va.—Specification 4357, the Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to build an elevated steel water tank.

Electric Traveling Platforms and Hoist, Lakehurst, N. J.—Specification 4356, the Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to install electric traveling platforms and a hoist.

Water Tank, Chelsea, Mass.—Specification 4384, the Bureau of Yards and Docks, Navy Department, Washington, D. C., is receiving bids for the construction of a steel water tank tower and water mains.

TRADE PUBLICATIONS

Ellison Hardened Body Chuck.—A folder giving a complete description of Ellison hardened body drill chucks has been sent out by the E. Horton & Son Company, Windsor Locks, Conn.

The Labor Saver.—The April issue of the monthly publication of the Stephens-Adamson Mfg. Company, Aurora, Ill., contains articles on the uses of belt conveyors in handling such materials as coal, brick, ores and the like.

The Chart, the house organ of the Los Angeles Shipbuilding & Dry Dock Company, Los Angeles, Cal., will hereafter be issued as a monthly instead of bi-weekly publication. The magazine will appear enlarged in size and with colored covers, and will take a leading place in monthly publications of this type.

Forced Draught.—In Bulletin A-2 the James Howden & Company of America, Inc., Wellsville, New York, emphasizes the importance of the correct arrangement of forced draught systems and the necessity of care in the selection of equipment. General specifications for the complete Howden system are given.

The Cochrane Lines.—Open feed water heaters, metering heaters, independent meters, hot process water softeners, oil and steam separators, multi port drainers and other of the products of H. S. B. W. Cochrane Corporation, Philadelphia, are described and illustrated in a pamphlet sent out by this company. These devices are intended for the profitable utilization of exhaust steam and for heating softening and metering water.

Vertical Inclosed Self-Oiling Engines.—Engberg vertical self-oiling engines ranging in horsepower from 1 to 100 are completely described in catalogue No. 301 issued by Engberg's Electric & Mechanical Works, St. Joseph, Mich. These engines are especially adapted for auxiliary service and for operation in conjunction with automatic stokers, compressors, refrigerating machines, generating sets, and the like. Illustrations and detail drawings with specifications show the various applications of Engberg engines.

FOREIGN ACTIVITIES

To Improve Harbor, Pernambuco, S. A.—The Government of Brazil has provided an appropriation for harbor improvements at Pernambuco, according to recent reports.

Cranes, Cadiz, Spain—Tenders are expected to be invited for the provision of four electric 1-ton cranes and three 2-ton cranes for use on the new docks of the Alphonso XIII wharf, Cadiz, Spain.

New Shipbuilding Company, Amsterdam, Holland—It is reported that a new shipbuilding company, to be known as the Nierdelandische Dock A.-G., has been organized for the purpose of building and drydocking vessels, etc.

Italy.—The tonnage under construction in Italy amounts to 57 steel steamships of 413,727 tons deadweight, of which 24 are already being fitted out. This is the largest tonnage under construction in any European country except Great Britain.

Shipyard Merger, Liverpool, England.—The business and premises of the Mersey Engine Works Company, whose establishment is in Sefton Street, and who have hitherto done most of the ship repair work for Elder-Dempter & Company, will be taken over by Harland and Wolff. The employes will be re-engaged by the new management.

Clyde Output.—The tonnage launched on the Clyde during the month of February, consisted of 25 vessels of 82,500 tons gross, as against 7 vessels of 11,000 tons, in January, 1921, and 21 vessels of 49,000 tons, in February, 1914. For the first two months of this year the total output of tonnage on the Clyde is 32 vessels of 93,500 tons. The output for the first two months of the year 1920, was 25 vessels of about 72,600 tons.

Royal Mail Leases Quay.—The Royal Mail Steam Packet Company has signed a lease of the Stettin Quay, Hamburg, Germany, for the period of 21 years with the State authorities. The length of the quay will afford berthing accommodation for two transatlantic liners at the same time. The inauguration of the company's New York service by the "O" steamers will take place shortly and passengers sailing on the Ortova on April 30, will find that everything has been done to facilitate their embarkation.

Cunard Tonnage, England—A statement issued recently by the Cunard Line, which lost more than 50 percent of its pre-war tonnage through submarine warfare, shows that when the present building programme is completed, it will have with its associated lines 1,018,000 gross tons, or more than double its tonnage before the war. There are nineteen new vessels under way, six of which are for the Anchor service with an aggregate tonnage of 317,000. Among the new ones are the Cameronia, nearing completion, and her sister ships the Caledonia, California, Tuscania and Transylvania, all named for war-lost ships of the Anchor Line. The three largest ships of the line are the Aquitania, the Mauretania and the Berengaria, formerly the German liner Imperator and the third largest afloat.

NEW CORPORATIONS

The Inoko Dredging Company, Wilmington, Del., was incorporated with a capital of $170,000.

The Baltimore Derrick & Salvage Corporation, Baltimore, Md., has been incorporated with a capital of $300,000.

The Calumet Steamship Company, Wilmington, Del., has been incorporated with a capital of $200,000 to operate and navigate steamships.

The Grace Line, Inc., New York City, has been organized by A. G. Bates with a capital of $100,000 to de a navigation business.

The Hawk Steamship Line, New York, has recently been incorporated with a capital of $100,000 by M. Bab and others.

The Importers' Steamship Corporation, Dover, Del., has been incorporated, with a capital of $1,000,000, to own and operate boats.

The American Transatlantic Line, Inc., Dover, Del., has been incorporated, with a capital of $500,000, to own and operate boats.

The Port Jefferson Marine Railway Corporation, Port Jefferson, N. Y., has been incorporated with a capital of $60,000 by W. D. and M. C. Allen and G. M. Tooker.

The Falls Cities Ferry & Transportation Company, Jeffersonville, Ky., incorporated, with Froman M. Coots president, to operate line between Louisville and Jeffersonville.

Weeks Stevedoring Company, Inc., Manhattan, incorporated, with a capital of $100,000, to do a general stevedoring business. F. H. Weeks, 2550 Marion Avenue, incorporator.

The King Philip Steamship Company, Boston, Mass., has been incorporated with a capital of $300,000, with John J. Dixon, 729 Boylston Street, president and treasurer, William F. McDonnough and James F. Casey.

The Eastern Shore Marine Railway Company, St. Michaels, Md., has been incorporated with a capital of $100,000 by Harold A. Harrison, James F. and Walter C. Lowery, to carry on a dry docking business, etc.

The Mount Pleasant Boat Building Company, Columbia, S. C., has been incorporated, with a capital of $5,000, with Robert Magwood president-treasurer, and C. E. North, secretary-manager.

The Atlantic Boiler Cleaning Company, Newport News, Va., has been incorporated, with a capital of $50,000, to do ship repairs, etc. F. S. Deniston is president, and H. M. Deniston is secretary.

The New Orleans-Bluefields Fruit & Transportation Company, New Orleans, La., has been incorporated, with a capital of $2,000,000, and two steamships have been purchased. Ferdinand Katz, of New Orleans, is reported to be interested in this new company.

The Cowles Marine Salvage & Manufacturing Company, 532 South Green Street, Chicago, Ill., has been incorporated with a capital stock of $250,000 by John T. Cowles, M. E. Harwich and James D. Davidson, to manufacture machinery for raising and salvaging sunken vessels.

The Carle Shipbuilding & Repair Company, Rockaway Beach, L. I., N. Y., has been incorporated with a capital of $25,000 by W. J. Francis, R. F. Lenahan and C. H. Carle, Rockaway Beach, to operate a shipbuilding and marine repair plant.

The Townsend Repair Works, Richmond, S. I., New York, has been incorporated with a capital of $50,000 by R. and J. A. Townsend and C. J. Nygard, Richmond, to operate a marine repair and machine works. C. A. Clayton, 44 Court Street, Brooklyn, is a representative of the company.

Tidewater Transportation Company, Washington, D. C., has been incorporated, with a capital of $2,500,000 to operate lines from Washington to Southern Maryland, with Harry Allyn, general manager, 513 G Street, N. W. The new company contemplates lines to Salisbury and Elkton, Md., on Eastern Shore.

The Los Angeles Launch & Tugboat Company has been formed at San Pedro, Cal., with a capital of $200,000, according to Henry Levinson, general manager of the Peterson Launch & Tugboat Company, which is reported to have organized the new concern. The tug Hero has been purchased from Puget Sound interests for the new company.

MARINE SOCIETIES

AMERICA

AMERICAN SOCIETY OF NAVAL ENGINEERS

Navy Department, Washington, D. C.

President—Capt. A. J. Hepburn, U. S. N.
Secretary-Treasurer—Commander J. S. Evans, U. S. N., Bureau of Engineering, Navy Department, Washington, D. C.
Annual meeting and election, first Tuesday in October, other meetings at call of the President.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS

29 West 39th Street, New York.

President—Rear Admiral W. L. Capps, C. C., U. S. N.
Secretary and Treasurer—Daniel H. Cox.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS

29 West 39th Street, New York City.

UNITED STATES NAVAL INSTITUTE

Naval Academy, Annapolis, Md.

President—Rear Admiral Bradley A. Fiske, U. S. N.
Secretary and Treasurer—Commander H. K. Hewitt, U. S. N.

NATIONAL ASSOCIATION OF MASTERS, MATES AND PILOTS

National President—John H. Pruett, 423 Forty-ninth St., Brooklyn, N. Y.
National Treasurer—A. B. Devlin, 187 Randolph Ave., Jersey City, N. J.
National Secretary—M. D. Tenniswood, 308 Vine St., Camden, N. J.

LIST OF OFFICERS, AMERICAN SOCIETY OF MARINE DRAFTSMEN

President—C. E. Deiser, 6124 Nassau Road, Philadelphia, Pa.
Vice-President—E. H. Monroe, 902 Virginia Ave., Washington, D. C.
Secretary—B. G. Barnes, 970 High St., Bath, Maine.
Treasurer—J. B. Sadler, P. O. Box 987, Norfolk, Va.
Executive Committeemen—G. W. Nusbaum, Washington, D. C.; A. H. Haag, Narberth, Pa.; John Thomson, Bethlehem, Pa.

NATIONAL MARINE ENGINEERS' BENEFICIAL ASSOCIATION OFFICERS

National President—Wm. S. Brown, 356 Ellicott Square Bldg., Buffalo, N. Y.
National Secretary-Treasurer—Geo. A. Grubb, 356 Ellicott Square Bldg., Buffalo, N. Y.

ATLANTIC COAST SHIPBUILDERS' ASSOCIATION

1701 Walnut Street, Philadelphia, Pa.

Secretary—C. S. King.

AMERICAN STEAMSHIP OWNERS' ASSOCIATION

17 Battery Place, New York

Vice-President and General Manager—Winthrop L. Marvin.

AMERICAN STEAMSHIP OPERATORS' ASSOCIATION

17 Battery Place, New York

CANADA

GRAND COUNCIL, N. A. OF M. E. OF CANADA

Grand President—E. Read, Rooms 10-12, Jones Building, Vancouver, B. C.
Grand Vice-President—Jeffrey Roe, Levis, P. Q.
Grand Secretary-Treasurer—Neil J. Morrison, Box 886, St. John, N. B.
Grand Conductor—E. A. House, Box 333, Midland, Ont.
Grand Door Keeper—Lemuel Winchester, 306 Fitzroy Street, Charlottetown, P. E. I.

GREAT BRITAIN

INSTITUTION OF NAVAL ARCHITECTS

5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

39 Elmbank Crescent, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORPORATED

The Minories, Tower Hill, London.

ITALY

COLLEGIO DEGLI INGEGNERI NAVAL E MECCANICI IN ITALIA,

Via Carlo Alberto 18, Genova.

Marine Engineering

Volume XXVI JUNE, 1921 Number 6

LIBRARY JUN 7 - 1921 U. S. PATENT OFFICE

Fig. 1.—Italian Passenger Steamship *Giulio Cesare*

Passenger Liner Giulio Cesare

Luxurious New Italian Liner to Engage in South American Passenger Service

A NEW addition to the passenger fleet of the world is the passenger liner *Giulio Cesare,* the construction of which has recently been completed at the Wallsend Shipyard of Messrs. Swan, Hunter & Wigham Richardson, Ltd., Wallsend-on-Tyne, England.

The vessel, which was built to the account of the Navigazione Generale Italiana, Genoa, for service between Genoa and Buenos Ayres, is of the following principal dimensions:

Length overall	632 feet	11	inches
Length between perpendiculars	601 feet	5	inches
Breadth, molded	76 feet	0	inches
Depth, molded to awning deck	53 feet	2⅜	inches

The *Giulio Cesare* was designed to meet the highest class of the Registro Nazionale Italiano, British Corporation and Lloyd's, and also to fulfill the requirements of the merchant shipping laws in Italy, the United States and Great Britain. In addition, she complies with all the requirements of the London Convention as regards subdivision, life-saving and other appliances.

The vessel has a straight stem and cruiser stern, two pole masts and two funnels.

Eight decks are fitted, with wide spaced pillars and girders, special attention being given to the superstructure, which is supported by specially designed external girders so that the interior decorations are not obstructed by pillars.

A cellular double bottom extends fore and aft, and is fitted for the carrying of both fresh and salt water, part of this space being reserved for boiler feed water and drinking water, and provision made for carrying ballast in the peaks and trimming tanks, the latter having large inlet valves in the ship's side for quick filling of these spaces.

A feature of the double bottom is that there are no bilges, the tank top plating being carried out to the skin of the vessel and drainage being arranged for by fitting wells.

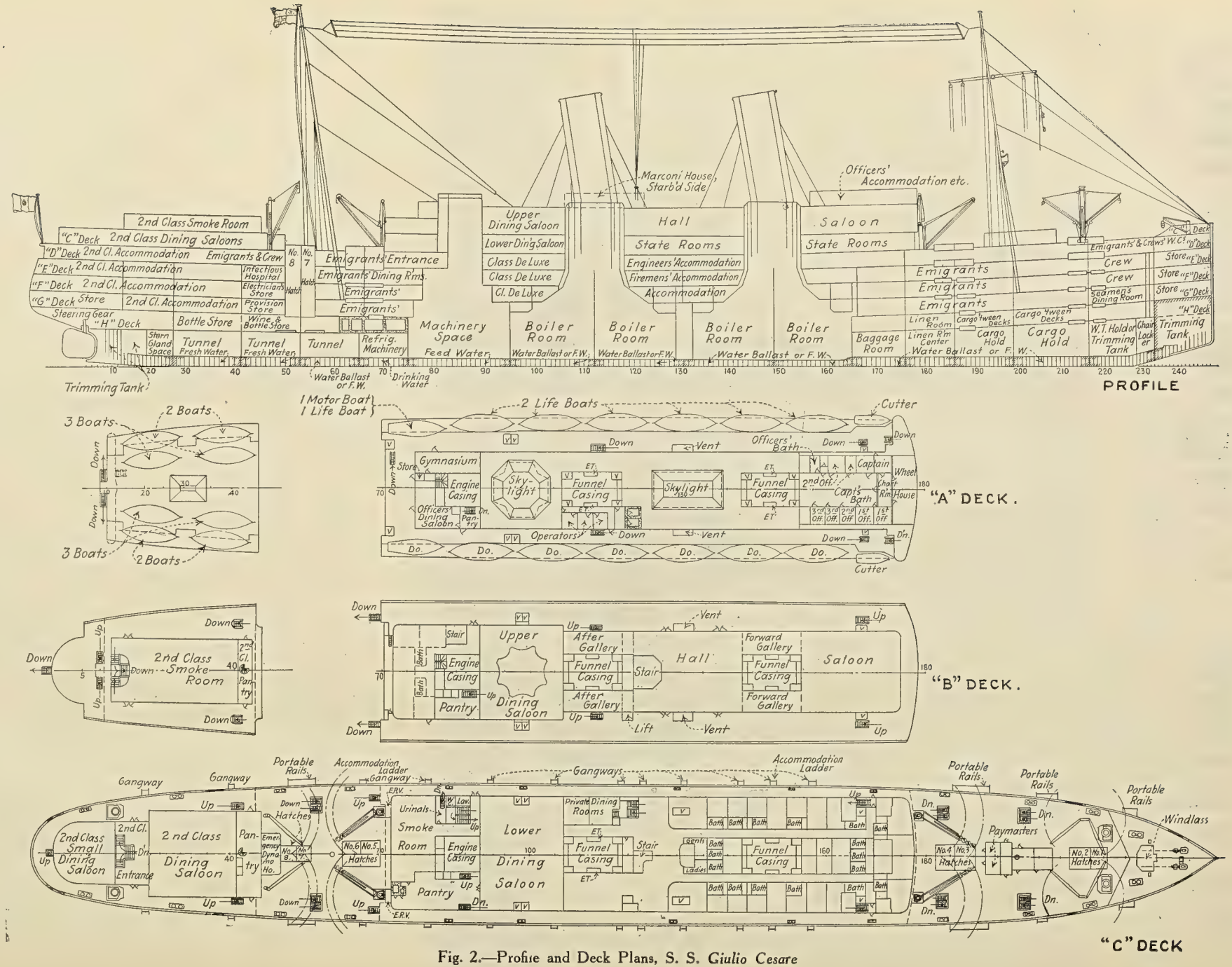


Fig. 2.—Profile and Deck Plans, S. S. *Giulio Cesare*

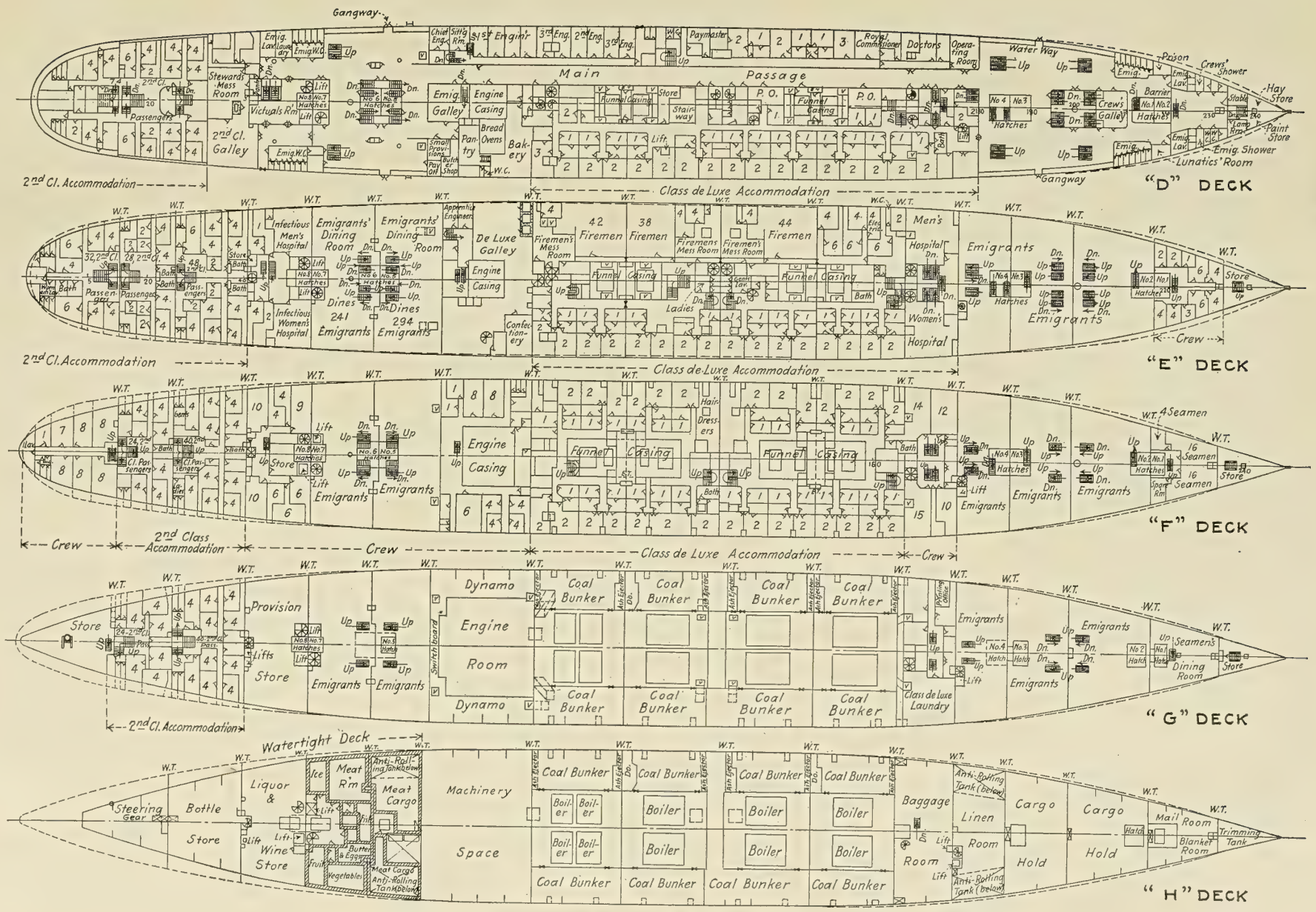


Fig. 3.—Deck Plans, S. S. *Giulio Cesare*

Passenger Liner Giulio Cesare

General Information

Service: Passenger—Genoa and Buenos Aires.

Builder: Messrs. Swan, Hunter & Wigham Richardson, Ltd., Wallsend-on-Tyne, England, Machinery by the Wallsend Shipway & Engineering Co., Ltd., Wallsend-on-Tyne, England.

Owner: Navigazione Generale Italiana, Genoa, Italy.

Characteristics

Length, overall .....632′ 11″
Length, B. P. .....601′ 5″
Breadth, molded ..... 76′ 0″
Breadth, extreme .....76′ 3½″
Depth, molded, to awning dk....50′ 2⅜″
Draft, loaded .....30′ 2″
Draft, light .....
Block coefficient .....
Midship section coefficient.....
Longitudinal coefficient .....
Speed, loaded, knots..... 19.5
Cruising radius, nautical miles.....
Framing .....Transverse
Class: Registro Nazionale Italiano, British Corporation and Lloyd's highest class

Tonnages

(In tons of 2,240 pounds)

*Weight of Hull.....
**Weight Propelling Machinery.....
Deadweight Capacity .....
Displacement .....

(In tons of 100 cubic feet)

Gross register 21,848
Net register 13,483

* Weight of Hull includes Hull Proper, Hull Fittings, Equipment, and Outfit.
** Weight of Propelling Machinery includes Engines, Boilers (Wet), Shafting, Propellers, and Machinery Space Auxiliaries.

Canal Ratings

(In tons of 100 cubic feet)

	Gross	Net
Suez		
Panama		

Equipment

2 Bower anchors, stockless.....146 cwts.
1 " " " .....124 "
1 Stream " ex. stock.....42¼ "
1 Kedge " " " ..... 22 "
Cable, 3⅜″ stud chain.....330 fms.
Stream line 7″ steel wire.....150 "
Towline, 7½″ " " .....140 "
9″ Manila, (3) each.....120 "
8″ Manila, (3) each.....120 "

Rudder

Area .....
Dia. Stock .....19″
C. Press. abaft C. L. pintles .....

Complement

Officers 30
Crew and attendants 512
Total officers and crew..... 542
First-class passengers..... 243
Second-class passengers..... 306
Third-class passengers 1,824
Total passengers 2,373
Total complement 2,915

Handling Equipment

	No.	Type	Capacity	Length
Masts	2	Pole	....	....
Derrick posts	4	....	....	....
Booms	4	Hydraulic jib		....
Booms	6	....	....	....

Deck Machinery

Steering Gear, steam-driven type, telemotor control.
Windlass (1) .....14″ x 16″
Capstans (4) .....14″ x 12″
Winches .....electric for handling boats
.....

Life Saving Equipment

	No.	Type	Length
Lifeboats	30	decked	30′-0″
Motorboats	2	....	31′-4″
Cutters	2	....	20′-0″
Lifeboats	12	....	31′-4″
Lifeboats	4	....	31′-0″

Propelling Machinery

Boilers

Number 10
Type, multitubular, 6 double ended, 4 single ended.
Length.....D.E. 22′ 0″ S.E. 11′ 6″
Diameter .....15′ 6″
Furnaces, total 36
Fuel .....Coal
Draft .....Forced
Total heating surface, square feet.....
Total grate surface or furnace volume.....
.....
Superheat, degrees F.....200
Working pressure, lbs, per sq. in.....220
Normal fuel consumption:
Per day, tons .....
Per horsepower hour, pounds.....
Normal steam production:
Per hour per pound of fuel.....lbs.
Total per hour.....lbs.

Engines

Number .....4 sets
Type.....single reduction geared turbines
Size .....
Horsepower, shaft 21,900

Propellers

Number 4
Type .....
Weight .....
Diameter .....
Pitch .....
R. P. M. .....
Projected area .....
Developed area .....

Auxiliary Machinery

Machinery Space

Condensers designed to maintain, at full power, a vacuum of 28½ inches with a barometer of 30 inches.
Evaporators (2), capacity 72 tons of water per day each.
Distillers (2), capacity 72 tons of water per day each.
Filters .....Gravitation type
Feed water heater..surface multiflow type
Fuel oil heaters.....aux. condenser (1)
Pumps:
(2) Main circulating-centrifugal type driven by vertical, single cylinder, double acting engines.
Main air—Ind. vert. dual type driven by one steam cylinder.
(2 Pairs) Main feed—single cylinder, direct acting.
(4) Aux. feed—single cylinder, direct acting, vertical type.
(1) Aux. circulating—centrifugal type driven by a single cylinder engine.
(1) Aux. air—single cylinder, direct acting monotype
Lubricating oil—single cylinder, direct acting, vertical type.
Oil cooling—vert. duplex type.
(2) Distiller circulating—vert. duplex type.
Reserve fire—placed low and driven through gearing by an electric motor located above the load waterline.
Ash ejecting pumps, vert. duplex type.
Steam driven ash hoist in each stokehold.
Hydraulic plant.
(3) Ballast—vert. duplex type, capacity 200 tons water per hour.
Deck service—vert. duplex type.
Fresh water—vert. duplex type.
Drinking water—vert. duplex type.
Sanitary and fire—duplex type.

Refrigerating Machinery

CO_2 brine type plant, made by G. and E. Hall, Ltd., Dartford, Kent, England.

Electric Equipment

Generators..(4 sets) 180 k.w. each, located in engine room.
Radio .....Marconi set
Emergency....(1) oil driven generating set.

Holds

No.	Length	Hatches
1.....	40′-0″	
2.....	31′-0″	
.....		

Capacities

Cargo Space

Compartment
.....
.....
.....
.....
.....
.....
.....
.....

Refrigerated Space

Compartment	Cu. Ft.
.....	
.....	

Bunkers

Compartment	Cu. Ft.	*Bbls.	*Tons
.....			
.....			
.....			
.....			
.....			
.....			

*....cu. ft. per ton;.....gals, per bbl.

Tanks

	Cu. Ft.	Tons F. W.	Tons S. W.
(4) drinking water			
(2) fresh water			
(1) salt water			
(4) boiler feed			
(24) fresh or salt water			
(2) anti-rolling tanks			
(2) trimming tanks			
Fore peak			
After peak			
.....			
.....			
Total			

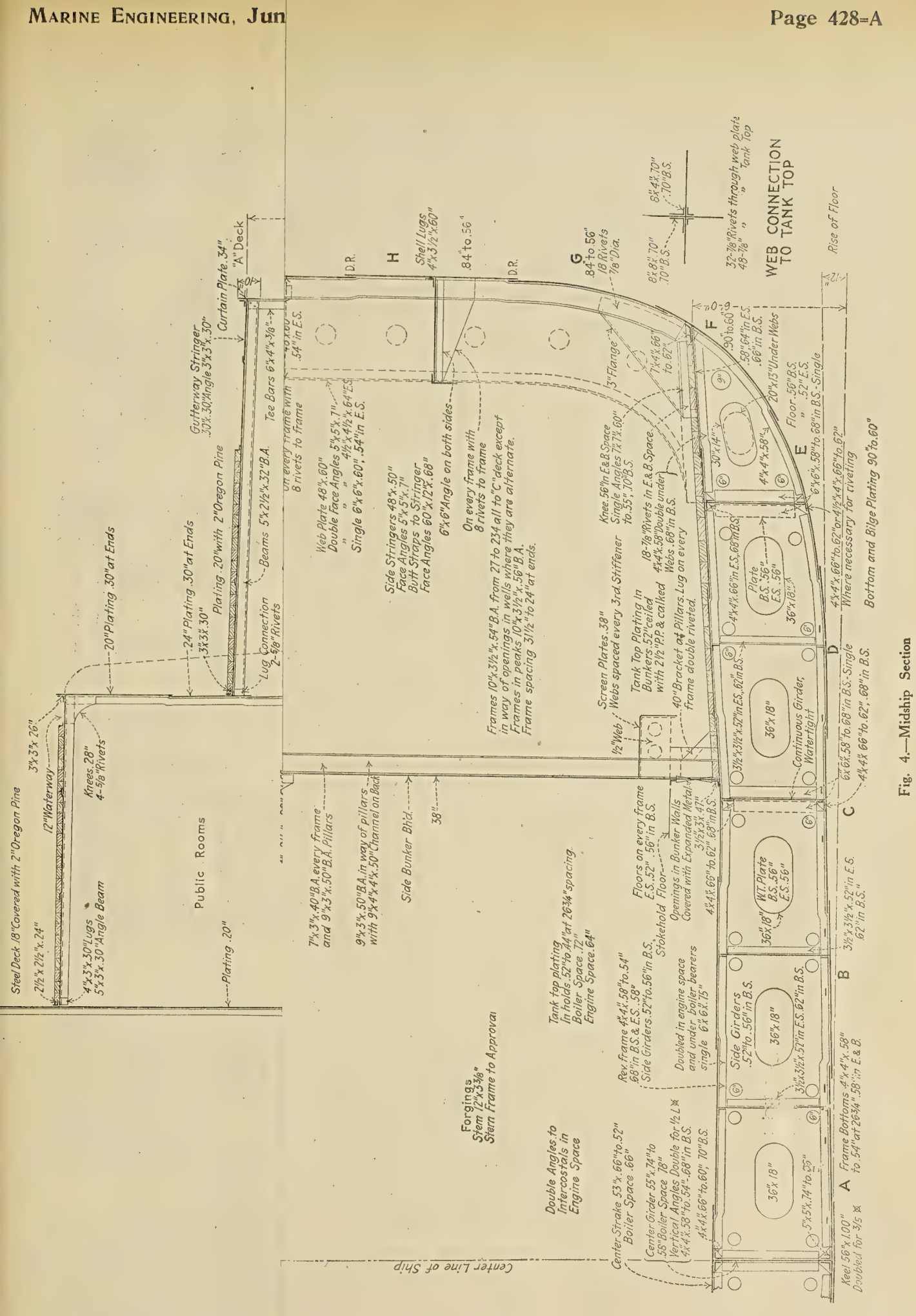


Fig. 4.—Midship Section

PASSENGER LINER GIULIO CESARE

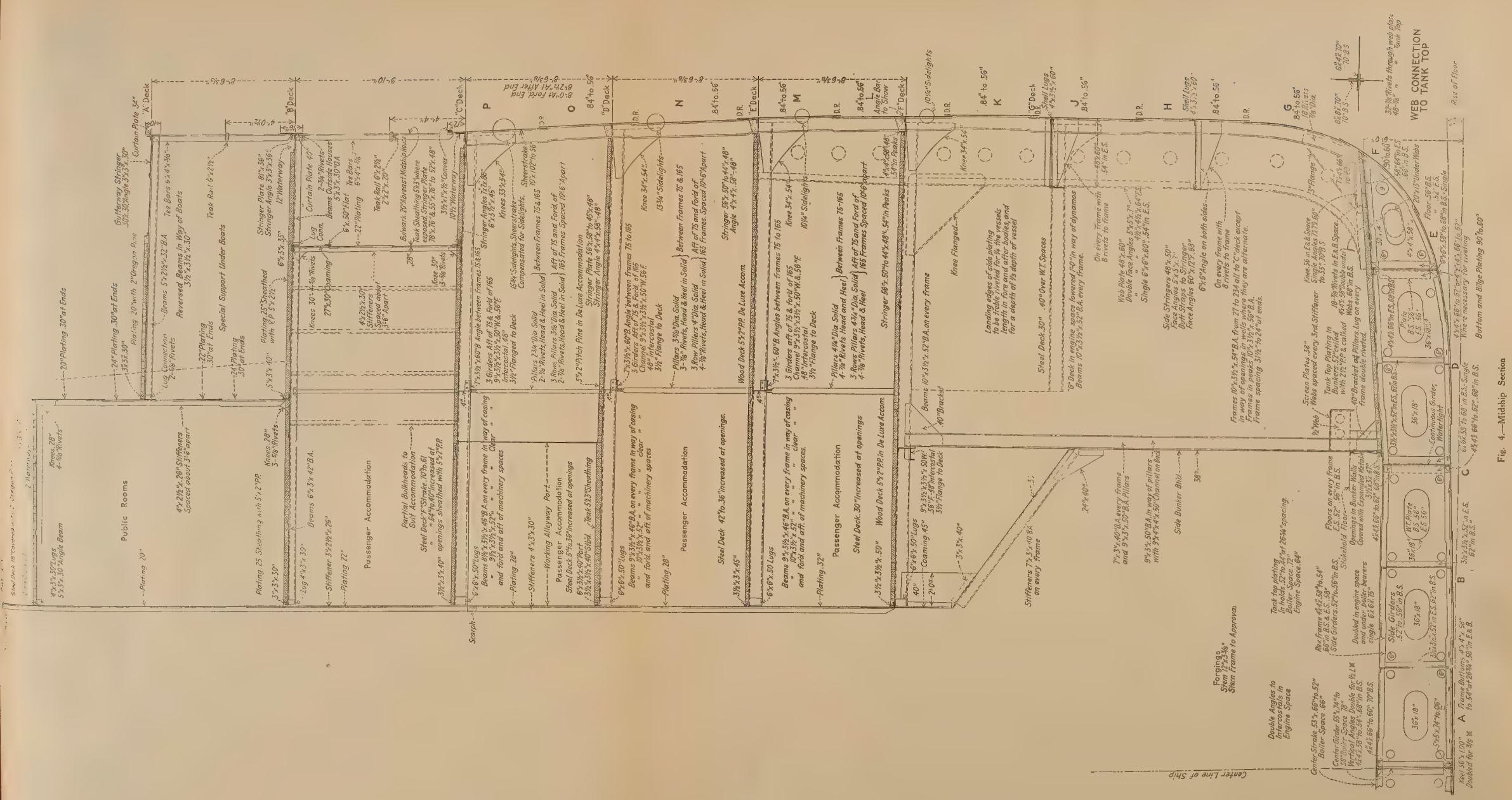
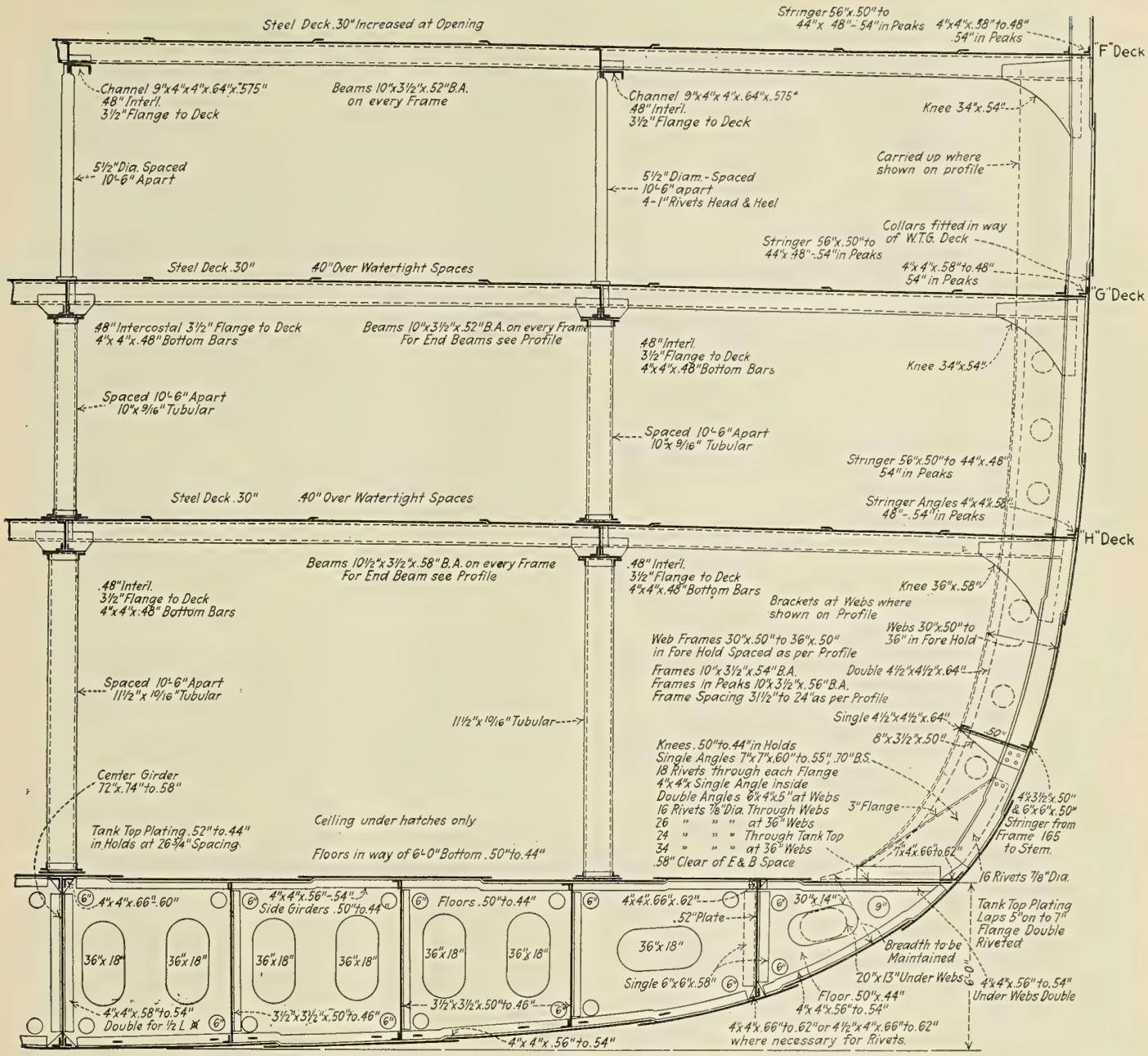


Fig. 4.—Midship Section



SECTION IN WAY OF HOLDS

Fig. 5

Two anti-rolling tanks are built into the ship's structure and the usual bilge keels are dispensed with.

The bulkheads between the engine and boiler rooms are intact, but access is obtained to the tunnels and machinery space by watertight doors, similar doors being also fitted in certain midship watertight bulkheads on *E* deck dividing the accommodation spaces.

Fire resisting bulkheads and doors are fitted in the central part of the vessel on the upper decks to prevent the spread of fire in the event of an outbreak.

Accommodations.

Accommodations are provided for 243 *de luxe* passengers in double and single berth cabins, private bath rooms with tile floors and walls being fitted one for every three passengers. A prominent feature of the first-class accommodations is the spacious and lofty superstructure comprising the entrance hall, galleries, library, saloon, etc. Special suite rooms are also arranged for, the entire accommodations being fitted out in a luxurious manner.

The second-class passenger accummodations provide for 306 to be berthed aft, generally in four-berth rooms, provision also being made for two dining rooms and a smoking room.

Accommodations for carrying 1,824 immigrants are provided in the 'tween decks forward and aft of the machinery space.

The captain, deck officers and wireless operators are accommodated in deckhouses above the midship superstructure, in which is also located the *de luxe* gymnasium. The engineers are berthed on the port side of the vessel on the awning deck in way of the engine room. The crew and attendants are berthed in various parts of the vessel.

Roomy promenade spaces are provided, the forward portion of that allotted to the *de luxe* passengers being inclosed by large windows of the railway carriage type.

Propelling Machinery

The propelling machinery and boilers were built and installed by the Wallsend Slipway & Engineering Company,

Ltd., Wallsend-on-Tyne. Four screws are provided, the power for driving which consists of four sets of single reduction gear turbines. The turbine sets consist of high and low pressure units working in series, which arrangement applies both to the ahead and astern going direction of rotation. The design of the turbines adopted is one having impulse wheel stages for all turbines, the high pressure ahead turbine containing 11 wheels in which the first wheel has two rows of blades, while the remaining wheels each have one row of blades. The low pressure ahead turbine contains 11 wheels, having a single row of blades to each wheel. The astern going high and low pressure turbines are each provided with one wheel having multiple rows of blades.

Arrangements are made whereby the high pressure and low pressure turbines can be operated independently should a breakdown occur to either. The admission of steam to the high pressure ahead turbine is under effective control by arranging the first stage nozzles in groups and providing each of these groups with its own controlling valve. Economy in consumption of steam is thus obtained as the number of nozzles open at one time can be regulated and a full pressure head of steam kept under a wide variation in load.

Six double ended and four single ended boilers of the ordinary multitubular type are provided and arranged in four watertight compartments with the single ended boilers placed aft. The boiler room arrangements are in accordance with the requirements of Howden's forced draft.

Superheating appliances are fitted to provide for a superheat of 200 degrees Fahrenheit at the turbine maneuvering valve.

The stacks are oval shape with outer casings carried the full height, the total height being 126 feet above the furnaces.

Air supply for the forced draft system is provided by 8 single ended type motor driven fans and suitable fan rooms are provided immediately above the stokeholds, the fans delivering the air down to the air heating boxes by means of trunks. Arrangements are made so that the operation of the fans can be controlled both from the fan room and the stokehold floor.

Trials

The sea trials of this vessel have just been completed and a satisfactory feature of the ship was the almost complete absence of vibration when running at top speed. A 24-hour trial at 19½ knots was run to test the vessel's speed, after which another trial of 24 hours' duration was run at a speed of 18½ knots to determine the coal consumption. Both trials passed off very successfully and to the complete satisfaction of the owners and builders.

Passenger and Cargo Vessel San Lorenzo

Reconditioned Vessel Placed in the New York to Porto Rico Service by the New York & Porto Rico Steamship Company

When the steamship *San Lorenzo* sailed for Porto Rico on March 12, the New York & Porto Rico Steamship Company had added to its high class passenger service what was virtually a new vessel. In her original design the *San Lorenzo,* ex-*Brazos,* was well known in the New York and Porto Rico trade. Last fall her owners turned her over to the Robins Dry Dock & Repair Company, Erie Basin, Brooklyn, N. Y., where from plans and specifications prepared by Theodore E. Ferris, naval architect, along lines laid down by Franklin D. Mooney, president of the New York & Porto Rico Steamship Company, the vessel has been rebuilt and refitted, the work having been carried through to completion under the supervision of Mr. Ferris.

The reconditioning of this vessel has greatly increased her passenger accommodations, there being more staterooms, and by clever designing more space was made available for the building in of suites de luxe. The new arrangement finds the officers' quarters on the upper deck, a plan which has proved successful on other passenger liners.

The *San Lorenzo* is a hurricane deck type ship having main, lower and orlop decks. She carries a double bottom under the boiler space, and built-in fresh water tanks. There are five transverse bulkheads.

The principal changes in the vessel as a result of reconditioning are as follows:

Hull

The break in the deck house aft has been eliminated and the boat and promenade deck constructed to extend from the bridge all the way aft. New fresh water and fuel oil

Fig. 1.—S. S. *San Lorenzo,* Reconditioned for New York and Porto Rico Service

Fig. 2.—Interior Views of S. S. *San Lorenzo:* (1) New Companionway, (2) Dining Saloon, (3) Dancing Deck, (4) Sun Parlor, (5) Reading and Writing Room, (6) Smoking Room

Passenger and Cargo Vessel San Lorenzo

General Information

Service: Freight and passenger, New York to Porto Rico.

Builder: Newport News S. B. & D. D. Co., Newport News, Virginia.

Designer: Theo. E. Ferris, 30 Church St., New York.

Owner: New York & Porto Rico Steamship Co., New York.

Characteristics

Length, overall	416′-0″
Length, B. P.	400′-0″
Breadth, molded	54′-0″
Depth, molded to hurricane deck	37′0″
Draft, loaded	24′-0″
Draft, light	12′-10″
Block coefficient	0.684
Midship section coefficient	0.967
Longitudinal coefficient	0.706
Speed, loaded, knots	14
Cruising Radius, nautical miles	5,150
Framing	Transverse
Class	

Tonnages

(In tons of 2,240 pounds)

*Weight of Hull	3,650
**Weight Propelling Machinery	1,250
Deadweight Capacity	5,300
Displacement	10,200

(In tons of 100 cubic feet)

Gross register	6,605
Net register	4,035

* Weight of Hull includes Hull Proper, Hull Fittings, Equipment, and Outfit.

** Weight of Propelling Machinery includes Engines, Boilers (Wet), Shafting, Propellers, and Machinery Space Auxiliaries.

Canal Ratings

(In tons of 100 cubic feet)

	Gross	Net
Suez		
Panama		

Equipment

Anchors

Chain

Rudder

Area

Dia. Stock ... 11″

C. Press. abaft C. L. pintles

Complement

Deck officers	4
Deck crew	18
Engineer officers	4
Engineer crew	27
Purser's and steward's department	81
Total officers and crew	134
First-class passengers	216
Second-class passengers	
Third class passengers	
Total passengers	216
Total complement	350

Handling Equipment

	No.	Type	Capacity	Length
Masts (1 dummy)	2	Pole	....	68 ft. above deck
Derrick	1	Steel	30 Tons	51 ft.
Booms	4	Wood	8 Tons	2-50 ft. 2-42 ft.

Deck Machinery

Steering Gear

Windlass

Capstans

Winches ... (4) 8¼″ x 10″ single gear
(5) 8″ x 8″
(1) 10″ x 12″

Life Saving Equipment

	No	Capacity	Length
Lifeboats	12	35 persons	24′-0″
Lifeboats	2	30 persons	24′-0″

Propelling Machinery

Boilers

Number	6
Type	single-ended Scotch
Length, over heads	12′-4 3/16″
Diameter	15′-8″
Furnaces, each boiler	4
Fuel	Oil
Draft	Forced
Total heating surface, square feet	17,478
Total furnace volume, cu. ft.	439.8
Superheat, degrees F	
Working pressure, lbs. per sq. in.	215
Normal fuel consumption:	
Per day, tons	83.5
Per horsepower hour, pounds	1.2
Normal steam production:	
Per hour per pound of fuel	lbs.
Total per hour	lbs.

Engines

Number	2
Type	quad. exp. recip.
Size	23 5/16″ x 48 7/16″ x 33¾″ x 68″
Horsepower	6,500

Propellers

Number	2
Type	3 bladed—built up
Weight	
Diameter	15′-0″
Pitch	19′-0″
R. P. M.	70
Projected area, square feet	51.0
Developed area, square feet	63.3

Auxiliary Machinery

Machinery Space

Main Condensers (2) each 5,025 sq. ft. cooling surface

Aux. Condenser (1) 1,000 sq. ft. cooling surface

Evaporators

Distiller

Filters (1) feed and filter tank. 2,400 gals.

Feed water heater (1) Griscom-Russell No. 30.

Fuel oil heaters ... 3

Pumps

(1) Main air, vert. twin beam. 12 x 28 x 18.
(1) Main circulating, size 15″.
(1) Main feed, vert. simplex, 14 x 10 x 24.
(1) Aux. feed, vert. simplex, 14 x 10 x 24.
(1) Fire, bilge and general service, vert. duplex, 12 x 8½ x 12.
(1) Aux. condenser circulating, vert. simplex, 12 x 14 x 12.
(1) Sanitary, vert. duplex, 7½ x 9 x 10.
(1) Freshwater, vert. duplex, 7½ x 5 x 6.
(2) Fuel oil, vert. duplex, 6 x 4 x 6.
(1) Oil transfer, vert. duplex, 7½ x 6 x 10.

Refrigerating Machinery

(3) 4 ton ice machines—Brunswick.
(1) con. circ. pump, vert. duplex, 7½ x 5 x 6.
Scuttle butt (1) 90 gals.
(1) Circ. pump, vert. duplex 4½ x 3¾ x 4.

Electric Equipment

Generators	(3) 30 kilowatts
Radio	
Emergency	

Holds

No.	Length	Hatches
1	65′-0″	10′-10″ x 10′-0″
2	56′-4″	8′-8″ x 12′-0″ 13′-0″ x 18′-0″
3	75′-10″	13′-0″ x 18′-0″ 10′-10″ x 12′-0″

Capacities

Cargo Space

Compartment	Bales Cu. Ft.
No. 1 hold	14,150
No. 2 hold	48,000
No. 3 upper hold	29,700
No. 3 lower hold (P & S)	9,500
Orlop 'tween decks (for'd.)	16,750
No. 1 lower 'tween decks	19,000
No. 2 lower 'tween decks	32,950
No. 3 lower 'tween decks	40,800
In way boiler casing (P & S)	9,600
In way engine casing (P & S)	4,700
Main 'tween dks. No. 1 cargo space	13,500
Main 'tween dks. No. 2 cargo space	6,750
Main 'tween dks. No. 3 cargo space	5,450
Main 'tween dks. No. 4 cargo space	26,900
Total	277,750

Refrigerated Space

Compartment	Cu. Ft.
Cargo cold storage (port)	2,000
Cargo cold storage (starb'd)	850
Cargo cold storage (starb'd	850
Meat	1,050
Fruit	820
Vegetables	630
Total	6,200

Bunkers

Compartment	Cu. Ft.	*Bbls.	*Tons
Double B.T.M. Tank (P)	4,950	880	134
" " " (S)	4,950	880	134
Deep Tank (P)	9,500	1,696	257
" " (S)	9,200	1,642	249
Wing Tank (P)	9,390	1,673	254
" " (S)	9,390	1,673	254
Total	47,380	8,444	1,282

2 percent deduction allowed for expansion.

* 36.97 cu. ft. per ton; ..... 42 gals. per bbl.

Beame = 14

Tanks

Compartment	Cu. Ft.	Tons F. W.	Tons S. W.
Frs. 124-130 Port	4,460	124	
Frs. 124-130 Starb'd	4,460	124	
Frs. 124-130 C. L.	970	27	
Frs. 154-160	1,405	39	
Frs. 160-165	1,320	37	
Fore Peak	2,700	75	77
Aft Peak	9,400	261	269
Total	24,715	687	346

tanks to suit the new oil burning arrangement have been built into the hull and the entire vessel scaled and surveyed, such portions of the hull as necessary being renewed or repaired.

Engines

The engines have been thoroughly overhauled and brought into first class working condition.

Boilers

Six new boilers built by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., are installed in the vessel to take the place of the old boilers which were removed. The new boilers are fitted for burning oil, the oil burning installation being of the type manufactured by the White Fuel Oil Engineering Company. Fuel oil is carried in the double bottom tanks which are fitted with the necessary heating coils and grids.

In connection with the new fuel system, all equipment for the use of coal, such as ash ejectors, ash hoists and other appliances of this kind have been removed. The coal ports on the port and starboard sides of the lower deck have been permanently closed and a new boiler hatch built to suit the latest arrangement, the top or fidley being fitted with gratings and hinge covers. The new fireroom is served by four ventilators 48 inches in diameter operated with turning gear from the fireroom grating or lower deck level.

Piping

In order to supply the new arrangement of living accommodations, a completely new system of water piping was necessary throughout the ship. This included both fresh and salt water as well as sanitary piping for the toilets.

To make this vessel comfortable in cold weather, the steam heating system was entirely re-piped, using as many of the old radiators as possible after having thoroughly cleaned and put them in first class condition.

Electrical Work

An entirely new and complete installation of electric lighting was fitted throughout the vessel. Annunciator and call systems were also installed in all quarters.

Accommodations

A Deck.—With the new arrangement, the boat, or *A* deck as it is now termed, will have the accommodations for the deck and engineer officers, engine crew, petty officers, cooks, pantry men, etc., located at the forward end. Aft of these is located a sun parlor and smoking room both of which are luxuriously fitted out. A refreshment room and barber shop are located abreast the smoking room. Further aft is a shelter deck enclosure which with its wide windows and doors will be a popular resort in rainy weather. The wireless room is in a separate house near the stern, being located in the center of what is termed the dancing deck, an open space for the amusement of the passengers.

The lifeboats are also located on this deck and are strung out amidships, there being fourteen lifeboats provided, each capable of holding thirty-five persons.

Promenade or B Deck.—The promenade or B deck begins at the bridge the same as the deck above. The lounge and music rooms are located at the forward end and are fitted with large windows which provide a pleasing view ahead. Aft of that room are four suite staterooms consisting of a stateroom and bath. Sleeping accommodations in the form of two separate beds with a folding berth above provide ample comfort for a small family.

These are followed by two-berth staterooms at the port and starboard sides of the ship which extend as far aft as the social hall, which is built around the main stairway leading from the decks below.

Aft of the social hall are eight suite staterooms and from this point on, two-berth staterooms are carried to the stern, sufficient space being left at the extreme stern to provide open deck space for walking from one side of the ship to the other. A promenade is afforded on both sides of the vessel between the deck house and the ship's side for the full length of the deck.

Hurricane or C Deck.—The hurricane or *C* deck has a small steel deck house forward containing the seamen's quarters and boatswain. There is an open space between the forward house and main house on this deck which comes in line with the bridge and decks overhead. On the forward end of the main deck house is a dining saloon which is arranged to give the maximum accommodation and comfort in order to overcome the set and stiff appearance so often seen in dining rooms in even the largest steamers afloat. Some of the larger tables in the central part of the room will seat eight people and others will accommodate six at one time. For smaller families tables seating three will be found, while tables for two are located against the bulkheads. The main pantry is directly aft of the dining room and is served by a dumbwaiter from the galley on the deck below, this same dumbwaiter also being used to furnish food for the officers' mess above.

Two-berth staterooms are built on both the port and starboard sides from here aft to the social hall, located on this deck amidships directly under the social hall on the deck above. The chief steward has a stateroom forward near the main pantry on the starboard side and the purser's room is on the same side, but further aft, being opposite the main stairway to the deck above.

The inside finish of all the quarters was planned to be neat, artistic and in good taste with the surroundings. Mahogany finish has been adopted in many places and fumed oak in the smoking room. Leaded glass doors or screens of appropriate design lend attractiveness to the principal rooms and a white enamel finish tinted with gold stripe marking adds to the attractiveness of the public rooms.

Launching of 33,000-Ton Battleship *Colorado* at Yards of New York Shipbuilding Corporation. Vessel Will Be Driven at 21 Knots by Westinghouse Electric Propelling Equipment of 32,000 Horsepower

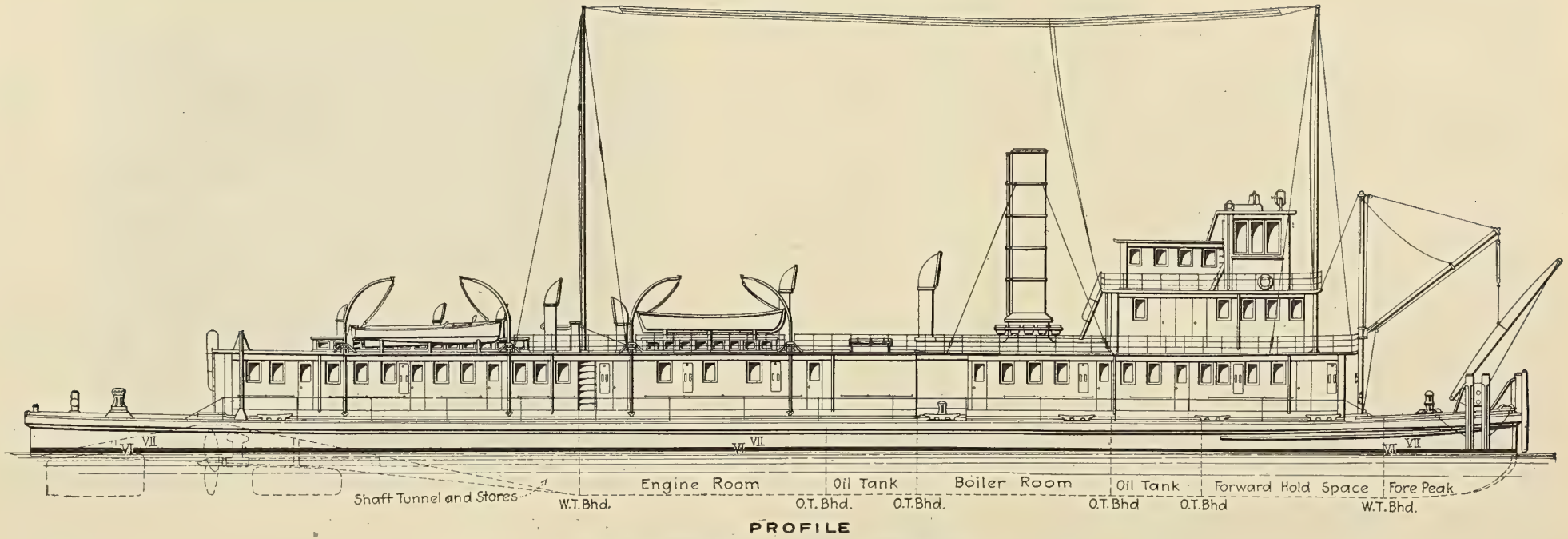


Fig. 1.—Outboard Profile of River Towboat *Natchez*

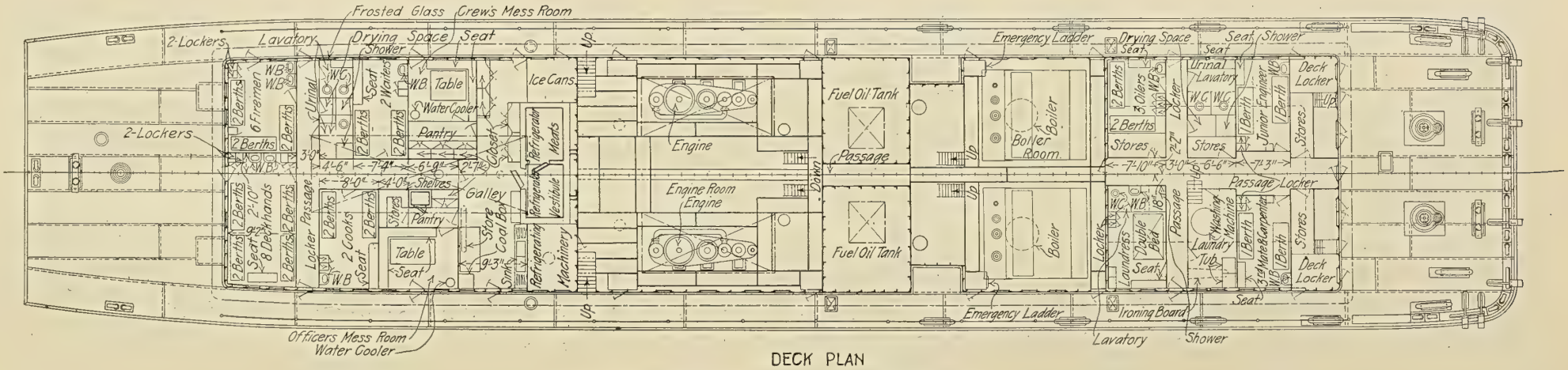


Fig. 2.—Main Deck Plan of River Towboat *Natchez*

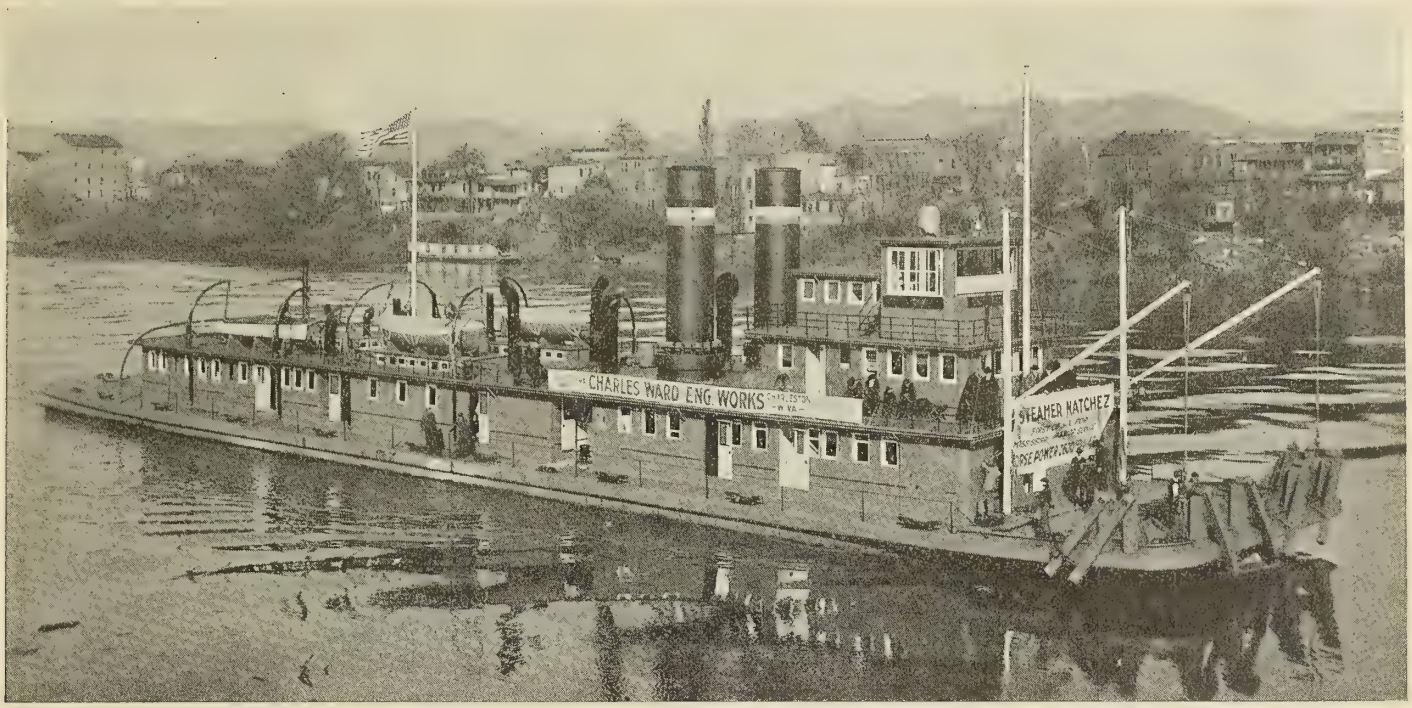


Fig. 3.—Twin-Screw Tunnel-Stern Towboat *Natchez*

Mississippi-Warrior River Towboats

Description of the Natchez, the Most Powerful River Towboat Ever Built—The First of Six to be Operated by the Government

THE steamer *Natchez,* the first of a fleet of six powerful twin screw tunnel towboats, designed by Cox and Stevens, naval architects, New York, for service on the Mississippi River was recently completed and delivered to the Government by The Charles Ward Engineering Works, Charleston, W. Va.

These boats are the most powerful river towboats that have ever been built in this country or abroad. They are to be operated by the War Department, under direction of the Chief of Inland and Coastwise Waterways Service, as the Federal Barge Line, of which Mr. Theodore Brent is Federal manager at New Orleans and Colonel G. E. Humphrey manager at St. Louis.

Under normal conditions these boats are to handle from five to six steel barges; each barge to be 45 feet wide by 230 feet long with a draft of from 7 feet to 10 feet, depending on the stage of water in the rivers, and having a maximum carrying capacity of about 2,000 tons.

The *Vicksburg,* a sister ship of the *Natchez,* is nearing completion at the plant of The Charles Ward Engineering Works, and the Marietta Manufacturing Company, Point Pleasant, W. Va., is building the other four vessels, two of which are nearly finished.

All the vessels are duplicates and of the following dimensions:

Length	200 feet
Beam	40 feet
Depth	10 feet
Draft	6½ to 7 feet

General Arrangement

The vessels are equipped with every modern convenience for efficient operation and the comfort of the crew, including steam heat, hot and cold water, numerous shower baths, electric fans, a laundry with electric washing machine and, to provide constant communication with the terminals at New Orleans, a complete wireless system will be installed, the masts for which are already in place.

Figs. 2 and 3 show the general arrangement of the quarters and machinery.

Hull

The boats are very strongly constructed of steel throughout in order to withstand the heavy towing which will be required. The framing is unusually heavy for vessels of this type, the floors being 30 inches deep, except in the way of the engines where they are reduced to 24 inches, and spaced 21 inches center to center. Double bottoms are provided extending from the aft engine room bulkhead to the collision bulkhead, except in the way of oil tanks where the tank top is omitted to provide for additional oil storage. The plating is ⅜-and 5/16-inch thick, double riveted. There are three longitudinal girders, one on the center line and one on each side 15 feet 6 inches from the center.

Main Propelling Machinery

Each vessel is driven by two triple expansion condensing engines having cylinders 15½, 25 and 44 inches diameter by 26 inches stroke with piston valves on all cylinders operated by the regular Stevenson link motion. The crank shafts are 8⅜ inches diameter of the built-up type with forged steel crank webs. Thrust blocks of the usual horseshoe type are fitted in with thrust shafts having six collars 14½ inches diameter.

Auxiliary Machinery

The auxiliary machinery consists of a cylindrical steel shell condenser having 2,400 square feet of cooling surface; a centrifugal circulating pump, with 10-inch discharge, driven by an 8-inch by 8-inch vertical engine; a vertical beam air pump 9 inches by 20 inches by 12 inches stroke; two vertical simplex feed pumps 7 inches by 10 inches by 12 inches stroke

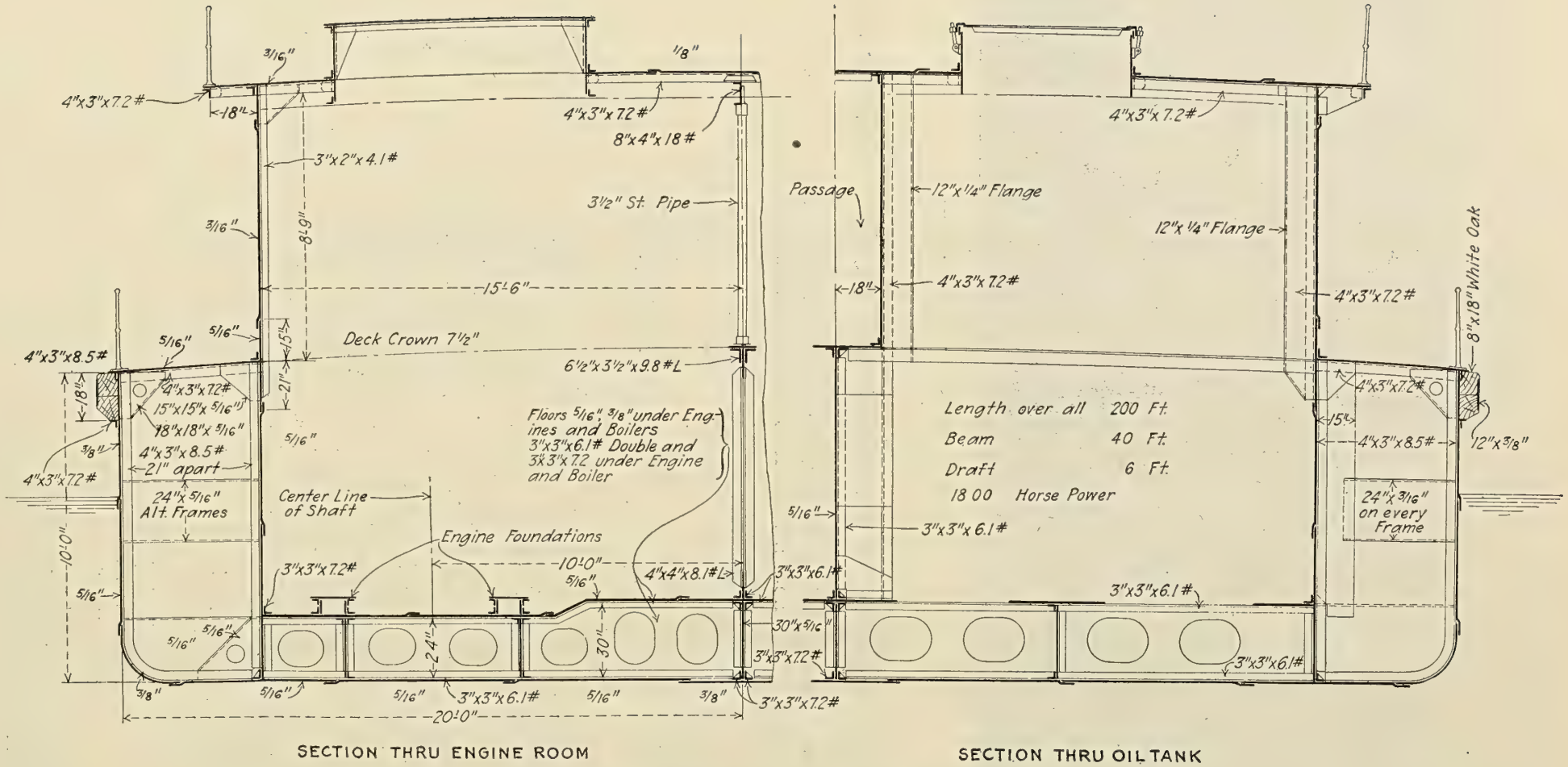


Fig. 4.—Midship Section, River Towboat *Natchez*

controlled by a float in the hot well; a Row & Davis feed water heater; two Engberg generating sets of 5 kilowatts and 10 kilowatts capacity; fire and bilge pumps; also a complete sanitary fresh water system in connection with a Permutit filtering and water purifying plant of 3,600 gallons capacity.

Refrigerating Plant

A complete Brunswick refrigerating plant of two tons capacity provides refrigeration for two cold storage rooms and small ice tanks.

Boilers

There are two Ward watertube marine boilers with 4,000 square feet of heating surface each, built for 250 pounds working pressure. The steam drums are 42 inches diameter by 12 feet long. Each boiler has 756 tubes 2 inches diameter and 42 tubes 4 inches diameter. The headers are constructed of steel plates 7/8 and 1 inch in thickness. Tube and handhole plates are stayed by the patent T-slot stay or division plate, no staybolts being used.

Oil Fuel

Each boiler is fitted with B. P. Lientz American oil furnaces and two Leahy burners. Steam is used for atomizing the oil. Forced draft is supplied by two wing blowers discharging into a wind box across the front of each boiler.

There are two fuel tanks with a total capacity of 319 tons of oil.

Propellers

There are two sectional four bladed propellers, each 9 feet 4 inches in diameter with a mean pitch of 8 feet 6 inches. The propellers work in tunnels of special design to provide an easy flow of water to and from the wheels.

Steam Capstans

Each vessel is fitted with four extra strong steam capstans of the usual Western river type, two located at the bow and one on each side just aft of the boilers .

Steering Gear

The arrangement of the rudders and steering gear requires special mention, there being four rudders located in the tunnels, two of them aft of the propellers and two forward. The rudders in each tunnel are controlled by an independent ram steering gear operated by oil under pressure, each pair of rudders being under control from the pilot house by means of a hand lever operating a floating valve on the ram, the position of the rudder being indicated by the position of the lever in the pilot house. Fig. 4 shows the general arrangement of rudder control.

The steering gear and independent operation of the rudders is the invention of Mr. T. R. Tarn.

The *Nantchez* developed during dock trials 2,237 indicated horsepower, the engines making 144 and 148 revolutions per minute, respectively, and the boilers operating under 250 pounds pressure. The safety valves blowing at intervals of about one and a half minutes showed that there was a large reserve of boiler power. Experience with vessels of this type shows that they will develop from 15 to 20 percent more power when operated in a tow of suitable size than during dock trials. This would give the vessels a total of 2,600 horsepower, which is nearly 40 percent above the contract requirements.

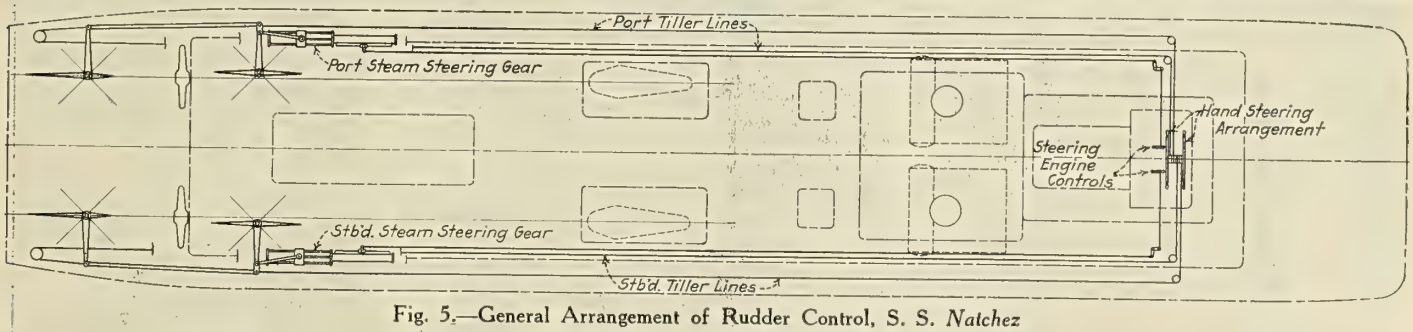


Fig. 5.—General Arrangement of Rudder Control, S. S. *Natchez*

New Board of Trade Survey Fees

The Board of Trade fees under Section 443 of the Merchant Shipping Act for survey and approval of load line have been raised in the usual upward direction. The following tables show the old and new fees:

Old Scale — Gross Tonnage of Vessels	Classed Vessels £	s.	d.	Unclassed Vessels £	s.	d.
Under 300 tons	1	1	0	4	0	0
300 tons and under 1,000 tons	2	2	0	6	0	0
1,000 " " 2,000 "	3	3	0	10	0	0
2,000 " " 3,000 "	4	4	0	13	0	0
3,000 " " 4,000 "	5	5	0	16	0	0
4,000 " " 5,000 "	6	6	0	19	0	0
5,000 " " 6,000 "	7	7	0	21	0	0
6,000 " " 7,000 "	8	8	0	23	0	0
For every additional 1,000 tons	nil			2	0	0

New Scale — Gross Tonnage of Vessels	Classed Vessels £	s.	d.	Unclassed Vessels £	s.	d.
Under 100 tons	2	0	0	4	0	0
100 tons and under 300 tons	2	0	0	6	0	0
300 " " 500 "	3	0	0	8	0	0
500 " " 1,000 "	4	0	0	11	0	0
1,000 " " 1,500 "	5	0	0	14	0	0
1,500 " " 2,000 "	6	0	0	17	0	0
2,000 " " 2,500 "	7	0	0	20	0	0
2,500 " " 3,000 "	8	0	0	23	0	0
For every additional 1,000 tons up to 10,000 tons	1	0	0	3	0	0
For every additional 1,000 tons above 10,000 tons	nil			3	0	0

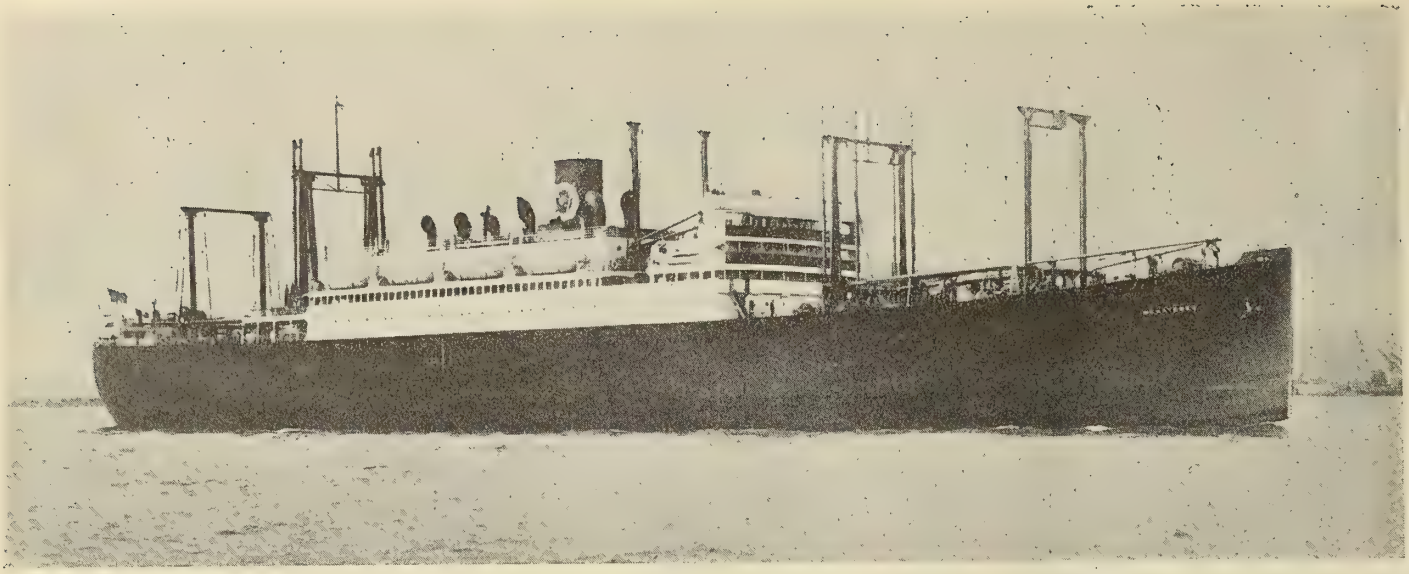
A special fee of £5 is also payable for the load line survey of an unclassed ferro-concrete vessel in addition to the fee prescribed in the third column of the above table.

The fee for an unclassed vessel should be charged for an unclassed wooden sailing or motor vessel *whether opened out for survey or not.*

When the fee as required by the last column of the scale above has been paid for the survey of an unclassed vessel, and when for special reasons a partial survey has been made and a certificate issued for a period not exceeding 12 months, only one-half of the full fee is payable for the completion of the survey for the renewal of the certificate of approval.

When owners or builders submit designs of new vessels and require provisional assignment of freeboard, the fee prescribed above should be paid according as the vessel is classed or unclassed. This will cover the final assignment of freeboard.

The fee for the inspection of minor alterations involving an alteration of freeboard in a vessel having a valid load line certificate is two-fifths the full fee chargeable.



(Photograph copyright by New York Shipbuilding Corp.)

Fig. 1.—Passenger Steamship *Wenatchee*

American Passenger Liner Wenatchee

The steamship Wenatchee, which was built by the New York Shipbuilding Corporation, Camden, N. J., and is now being operated by the Admiral Line between the Pacific Coast and the Far East, was originally ordered by the Government during the war as a hospital ship. Her design was, however, changed to a troop transport and when the war came to an end she was changed again into a de luxe passenger vessel.

WITH a length of 535 feet, a beam of 72 feet and draft of 36½ feet, the *Wenatchee* has a gross tonnage of 14,127, a net tonnage of 8,393 and can carry 250 cabin and 300 steerage passengers. She is an oil burner and is driven at 18 knots by Westinghouse turbines of 12,000 horsepower.

Undoubtedly, her most striking features are her luxurious fittings and her arrangements for the comfort and safety of her passengers and crew.

Her staterooms have twin beds, instead of berths, and are equipped with thermos bottles, shaving lamps, reading lamps over the beds, electric heat, steam heat, cold air (for use in the tropics), and in many cases, private baths. The public rooms, which are unusually spacious, are lighted by means of French windows, instead of ports, and most of the rooms have open fireplaces. In addition to the grand piano in the music room, there is a player-piano, for jazz, on the deck and

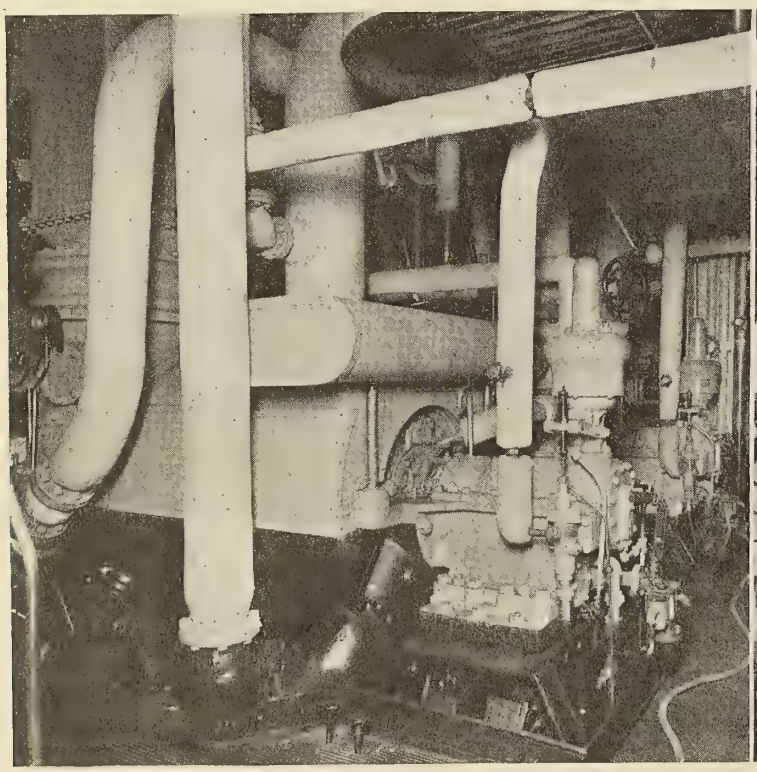


Fig. 2.—Main Turbines

Fig. 3.—Maneuvering Valves

a cabinet record player in the smoking room. The dining service is supplemented by a tea room and a veranda café. The furniture and finishings of all of the public rooms are very handsome and elaborate.

The broad decks are covered with rubber, and a wide promenade is glass-enclosed. A swimming pool on the boat deck will be especially popular on hot days and three hospitals—one for the passengers, one for the crew and one for contagious cases—will take care of those who fall ill on voyage.

There are eight cargo hatches, four forward and four aft. Each pair is served by a sampson post, instead of the usual king post, in order to expedite freight handling. The hatchways are large enough to admit a locomotive. The hull is divided into fourteen watertight compartments and the ship can float with any three flooded.

The *Wenatchee* is a twin screw vessel, and each propeller shaft is driven by a divided flow turbine rated at 6,000 horsepower. She has, therefore, four comparatively independent turbine elements, all four of which would have to be disabled before the ship could be disabled as far as turbine machinery trouble is concerned. An astern turbine, consisting of a single impulse wheel, is incorporated in each of the four turbine elements.

The turbines are designed for operation with steam at 250 pounds pressure with 75 degrees superheat and 28 inches vacuum, and consume 10.25 pounds per shaft horsepower at full-rated load.

The main condensers have an area of 8,000 square feet each, and will produce a vacuum of 28½ inches with 10,000 gallons per minute of circulating water at 60 degrees F. The circulating pump is turbine driven, as are also the condensate pumps. Vacuum is maintained by air ejectors. All of this auxiliary machinery is of Westinghouse make.

Electric current for lighting and power is furnished by four 50 kilowatt Westinghouse turbo generator sets. Each of these consists of a small impulse turbine geared to a slow speed direct current generator, the whole being assembled to form a compact unit.

Two sister ships of the *Wenatchee*, the *Sea Girt* and the *American Legion*, are being completed by the New York Shipbuilding Corporation and will be also equipped with Westinghouse turbines. Though these ships are just being completed, owing to the delays due to the several changes in their design, their propelling machinery was built during the war.

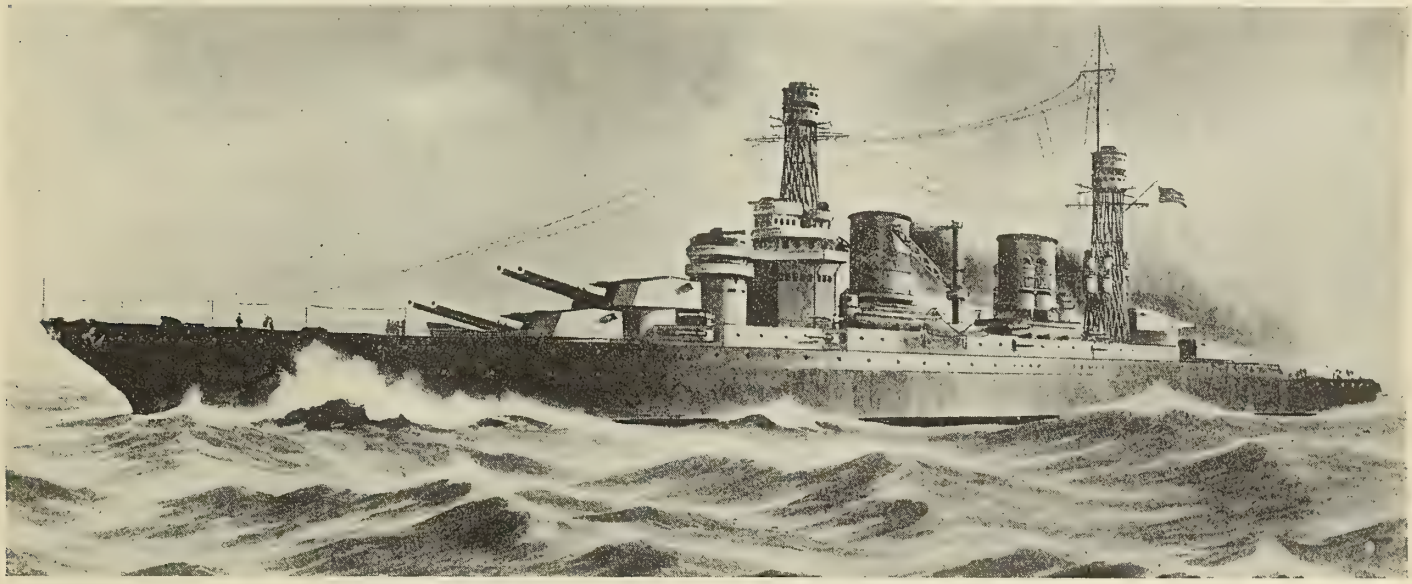
Dock Trials of Electrically Propelled Battleship Maryland Successful

THE superdreadnought *Maryland*, the third in order of completion of the electrically propelled battleships of the United States Navy, was given its official dock trials or first run under load at Newport News on May 2, 3 and 4, the trials proving satisfactory in every particular. The vessel is expected to go to sea late in June for the builders' sea trials and will be ready for acceptance by the Navy early in July.

In making the dock trials, the ship was secured to the dock with heavy cables and then the complete propelling machinery was set in operation in different combinations. The propelling machinery consists of two turbine generators, each designed to develop 11,000 kilowatts at a speed of 2,030 revolutions per minute to drive the ship at 21 knots; four induction motors, each rated at 7,025 horsepower at 170 revolutions per minute, which are directly connected with the four propeller shafts. The turbine generators also supply current for the operation of the electrically driven engine room auxiliaries.

During the trials, lasting 16 hours, with eight hour tests on each of the turbine-generator sets, the motors were operated separately and paired in various combinations, being subjected to strains equivalent to 21.5 knots at sea. The strain on the turbine-generators was equivalent to making 16 knots at sea, which represented the maximum amount of power that could be undertaken with safety.

The *Maryland* was built by the Newport News Shipbuilding and Dry Dock Company and the electrical equipment was manufactured by the General Electric Company. Two more battleships are being equipped at this yard with similar machinery, the *West Virginia*, which will be ready for its trial tests late in 1922, and the *Iowa*, which will be ready for tests in 1923.



United States Battle-Cruiser *Ranger*, as She Will Look When Completed

Battle-Cruiser Ranger

The photograph on this page, which is reproduced from a drawing, gives an excellent idea of the appearance of the United States battle-cruiser *Ranger*, now under construction at the yards of the Newport News Shipbuilding & Dry Dock Company at Newport News, Va. This vessel will be 874 feet long, displace 43,500 tons, and will have a speed of 33 knots. At this speed her Westinghouse electric propelling machinery will develop 180,000 horsepower. The main armament will consist of eight 16-inch guns.

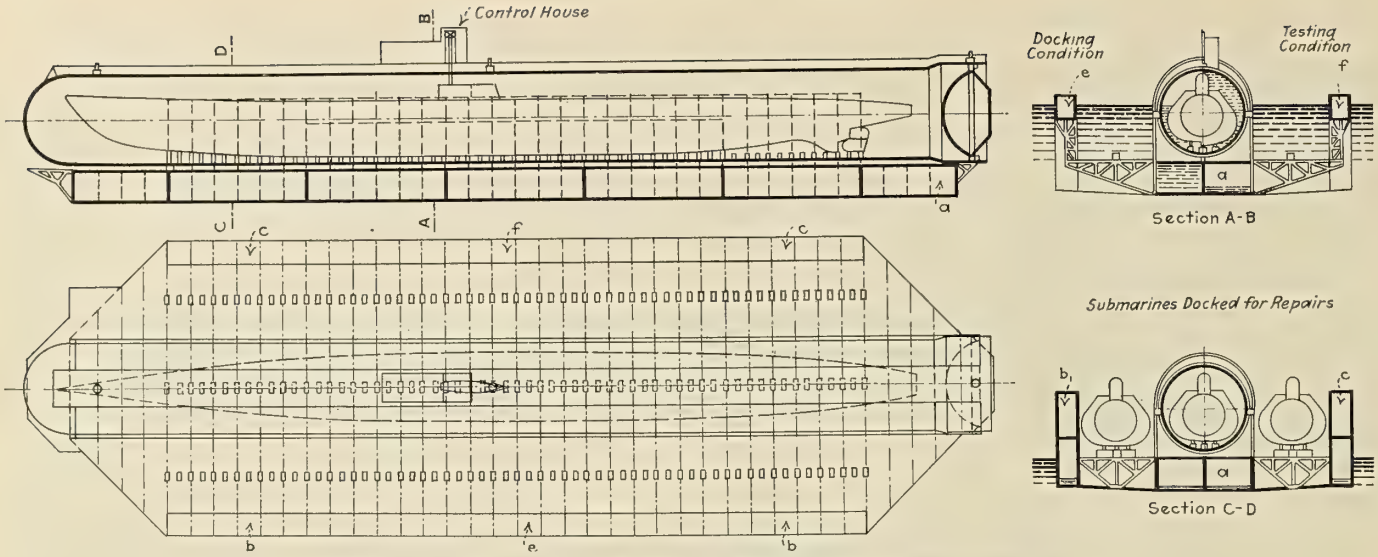


Fig. 1.—General Arrangement of Floating Dry Dock for Testing Submarines

Floating Dry Dock for Testing Submarines*

BY VON KLITZING

In 1916 construction was begun in Germany on a floating dry dock for testing submarines and during the summer of 1918 the dock was completed. By means of this dock submarines can be tested under pressures corresponding to a depth of 264 feet without the necessity of risking the loss of lives or vessel. In 1919, under the terms of the Armistice, the dock was turned over to the British Navy and is now being used for testing British submarines.

THE dock consists of a steel cylinder for testing submarines supported on pontoons with sufficient space on either side for docking a submarine for repairs. Pontoon "*a*" (Fig. 1.) has sufficient buoyancy to support the weight of the dock, the cylinder, and the submarines to be tested or repaired. The wing tanks "*b*" and "*c*" at the four corners of the dock serve to keep the dock on an even keel while being raised or submerged. The connecting tanks "*e*" and "*f*" provide stability when the dock is submerged, the submarines being tested with the dock partially submerged.

Testing Cylinder

The testing cylinder has a clear diameter of 39 feet 5 inches and a length of 380 feet 7 inches. One end is closed by a hemispherical bulkhead and the other end is open. The open end is fitted with a steel ring sheathed with hardwood. The cylinder is built up of steel plates with steel stiffening rings spaced 39.37 inches. All seams and butts are treble riveted and all rivets are countersunk on the inside of the cylinder. Three domes are fitted at the top of the cylinder, one in the center and one at each end, for collecting the air which is expelled when the cylinder is filled with water. Air pipes lead from these domes to the control house where they can be closed by means of cocks as soon as the cylinder is full. The middle dome is fitted with a safety valve. Access to the submarine to be tested is provided by a trunk (Fig. 2). Three manholes are fitted for access to the interior of the cylinder. Four large electrically operated slide valves provide for rapid drainage of the cylinder.

Caisson for Closing the Cylinder

The caisson for closing the open end of the cylinder consists of a floating vessel whose periphery is elliptical. One side of the caisson is spherically shaped and the other side is shaped like the frustum of a cone (Fig. 3). The spherical side takes the pressure while the other side is so formed as to give the proper stability to the caisson when floating. At the periphery of the caisson a steel surface is provided which lies against the wood sheathing of the steel ring at the end of the cylinder.

When pumping water into the cylinder, the pressure on the inside forces the caisson against the cylinder ring and thus prevents leakage. A counterweight, which can be rotated, is mounted inside the caisson. By means of a hand gear this weight can be rotated so that the caisson is turned through an angle of 90 degrees. It is necessary to turn the caisson through 90 degrees in order to get it through the similarly shaped elliptical opening of the cylinder.

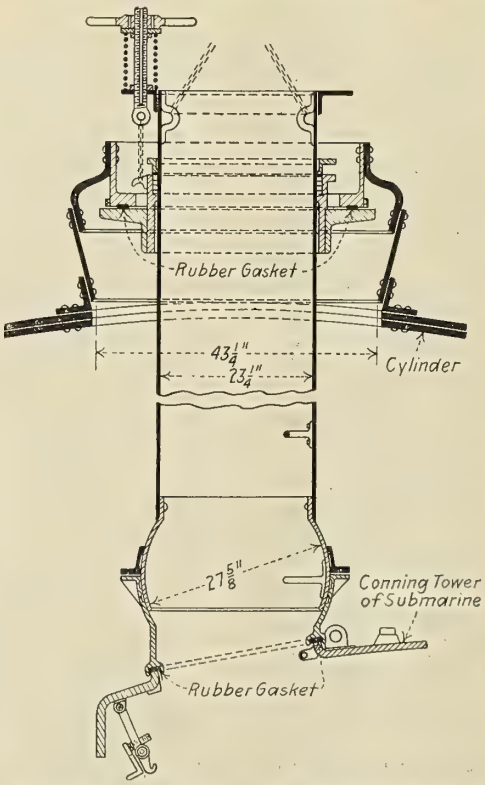


Fig. 2.—Details of Trunk Which Gives Access to Submarine Under Test

After the caisson has been brought into the cylinder it is

* From "Zeitschrift des Vereines Deutscher Ingenieure."

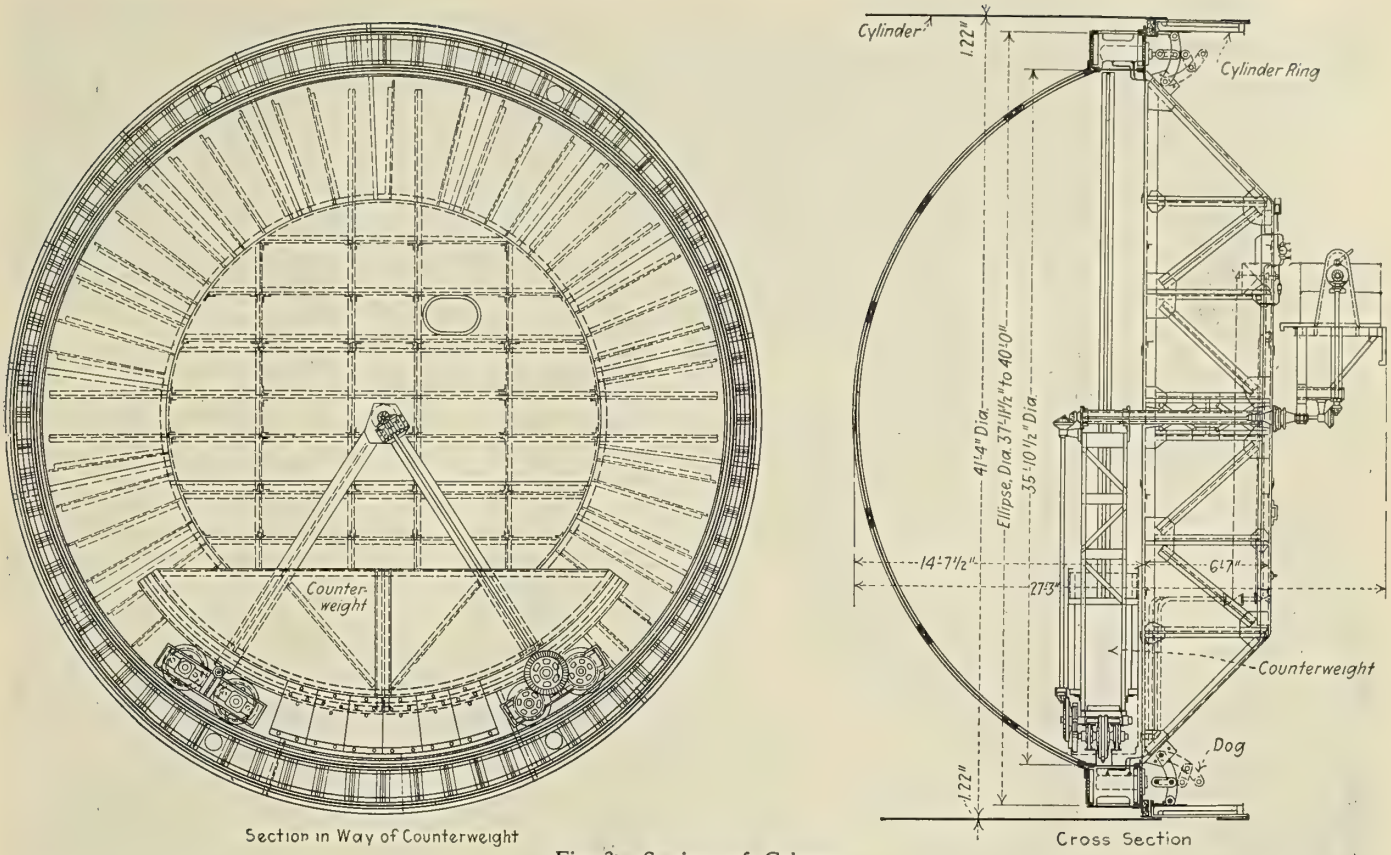


Fig. 3.—Sections of Caisson

returned to the upright position and brought against the cylinder ring so that the flanges are in contact all the way around. It is held in this position by dogs at the outside of the cylinder and pumping then begins. The caisson is divided into watertight compartments which are emptied or filled with water in order to regulate its floating position.

A roomy control house is located over the middle of the cylinder and contains all the apparatus necessary for raising or submerging and for testing the submarines. The apparatus is similar to that in use on modern floating dry docks and includes levers for the operation of the valves, draft gages for the different tanks and for the fore and aft drafts of the dock, hydraulic depth gages, and switches for the operation of the high and low pressure pumps and of the large slide valves for draining the cylinder.

Pumping Arrangement

Two low pressure pumps are used for raising or submerging the dock and for filling the cylinder. Two high pressure pumps are provided for increasing the pressure within the cylinder when testing submarines. The suction and discharge piping is arranged in two systems, one for each side of the dock and one low pressure pump is connected to each system. These systems are cross-connected so that one pump can be used for both. The discharge sides of the pumps are connected to the cylinder so that water pumped from the pontoons may be transferred to the cylinder without altering the draft of the dock. The various valves are controlled by means of rope pulls. The low pressure pumps are located near the bottom of the wing tanks and are driven by alternating current motors at 750 revolutions per minute. These motors are controlled from the control house.

The high pressure pumps are located in a small house beside the control house and have independent suctions from outboard. They are driven by motors, which are controlled from the control house, at 3,000 revolutions per minute. By means of a control valve, the pressure within the cylinder can be maintained at any desired point up to 117.5 pounds per square inch, which corresponds to a sea depth of 264 feet. The high pressure pumps are capable of attaining the pressure of 117.5 pounds in ten minutes.

The slide valves for rapid drainage of the cylinder have a 39.37-inch diameter opening. They are opened and closed by motors controlled from the control house. The position of the slide is shown at all times by an indicator in the control house.

Operation

For testing submarines, the dock is first submerged to a depth of about 40 inches above the center of the cylinder. The submarine is then towed in and the dock raised until the vessel rests on the keel blocks. Then the vessel is stayed from the sides and from above.

When the caisson has been floated into place and clamped and the access trunk connected up, the low pressure pumps are started and the cylinder is filled. The draft of the dock remains constant, as the water is transferred from the pontoons to the cylinder. The air escapes through floating valves in the domes at the top of the cylinder. When the water reaches the domes, the valves automatically close and the air which remains can escape only through the air pipes leading from the top of the dome to the control house. When the cylinder is completely filled water escapes through the air tubes in the control house. The tubes are then closed, the low pressure pumps stopped, and the high pressure pumps run until the desired pressure is obtained.

If submarines are to be docked for repairs on either side of the cylinder, the operations are like those of a floating dry dock. It is not necessary to have a vessel on each side of the dock, an even keel being maintained by water ballast.

When the dock was put in commission by the German Navy, tests were run on it with the following results: The time required for filling the cylinder was one hour and forty-two minutes; seven minutes were required to raise the pressure to 117.5 pounds; and six minutes were required to reduce the water level within the cylinder to the center of the cylinder.

Fig. 1.—200-Ton Flanging Press in Action at Boiler Shop of Federal Shipbuilding Company

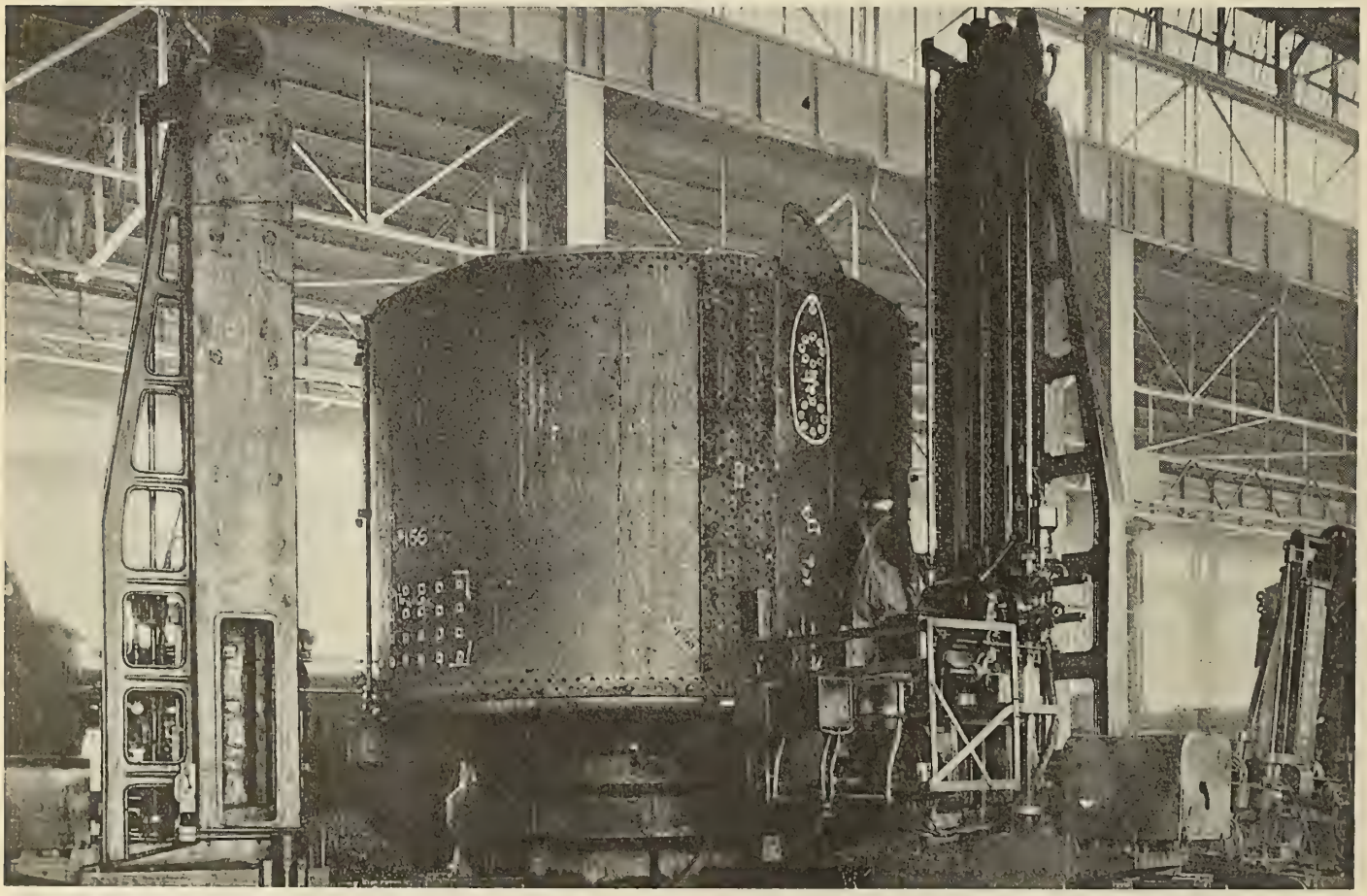


Fig. 2.—Triple Head Shell Drill, Having a Capacity of Shells from 8 Feet to 18 Feet in Diameter and 14 Feet Long

Quantity Production of Scotch Marine Boilers

With a normal output of three Scotch marine boilers a week, the boiler shop of the Federal Shipbuilding Company ranks with the most efficient shops in the country. The methods and equipment employed in the accomplishment of this construction, which for boilers of this type might be termed quantity production, are outlined in the accompanying article. While boilers for the ships under construction in the shipyard are being built, the stacks, uptakes and tanks for these ships are also fabricated in the boiler shop.

THE boiler shop of the Federal Shipbuilding Company, Kearny, N. J., primarily intended for Scotch marine boiler, stack, tank, uptake and light plate fabrication, is one of the largest in the country and is equipped with the best types of modern machinery for the efficient handling of work through the shop. Working normally with one eight-hour shift of 250 men, the output of the plant is three boilers a week. With the addition of another shift of about 100 men it is possible for the plant to turn out boilers on the basis of 200 a year. Since September, 1919, up to the present time, 235 boilers, most of them in excess of 15 feet in diameter, have been built in the shop. In addition, the stack, tank and uptake work for all vessels built in the Federal shipyard was carried on at the same time as the construction of boiler equipment.

The whole object in the arrangement of the shop, its equipment and the routing of material in the process of fabrication has been with the view to maintaining work on a production basis.

Structural Details of Shop

The building is a steel and terra cotta structure 585 feet long and 161 feet 6 inches wide, comprising a center bay 63 feet wide and 70 feet high below the roof truss. Two side bays, each 63 feet wide and 40 feet high flank the center. Partial extensions are arranged on the west end and south side for heating furnaces, and on the opposite side for the office, tool room, locker room and wash room.

For a distance of 85 feet the west end of the shop is free from columns and forms the flanging department. Next to this space central columns divide the main bay into two runs. For a distance of about 50 feet this section forms the riveting department. The middle stretch of the main aisle contains shell drilling equipment and forms the assembly floor. At the east end is the department in which hydraulic testing of the completed boilers is carried on. The north bay of the shop forms a department for the fabrication of light plate work. Standard gage railroad tracks enter each bay of the shop at the east end, and the north bay of the shop at the west end. Transverse 36-inch gage tracks connect the main aisle with the two side aisles.

Routing of Material

The shop is laid out for a straight line flow of materials, the direction being from the east end of the south bay to the west bay and then back through the main bay to the testing floor. When it reaches this point, the boiler is ready for shipment or installation in a vessel.

The north bay of the shop is utilized for tanks, stacks, up-

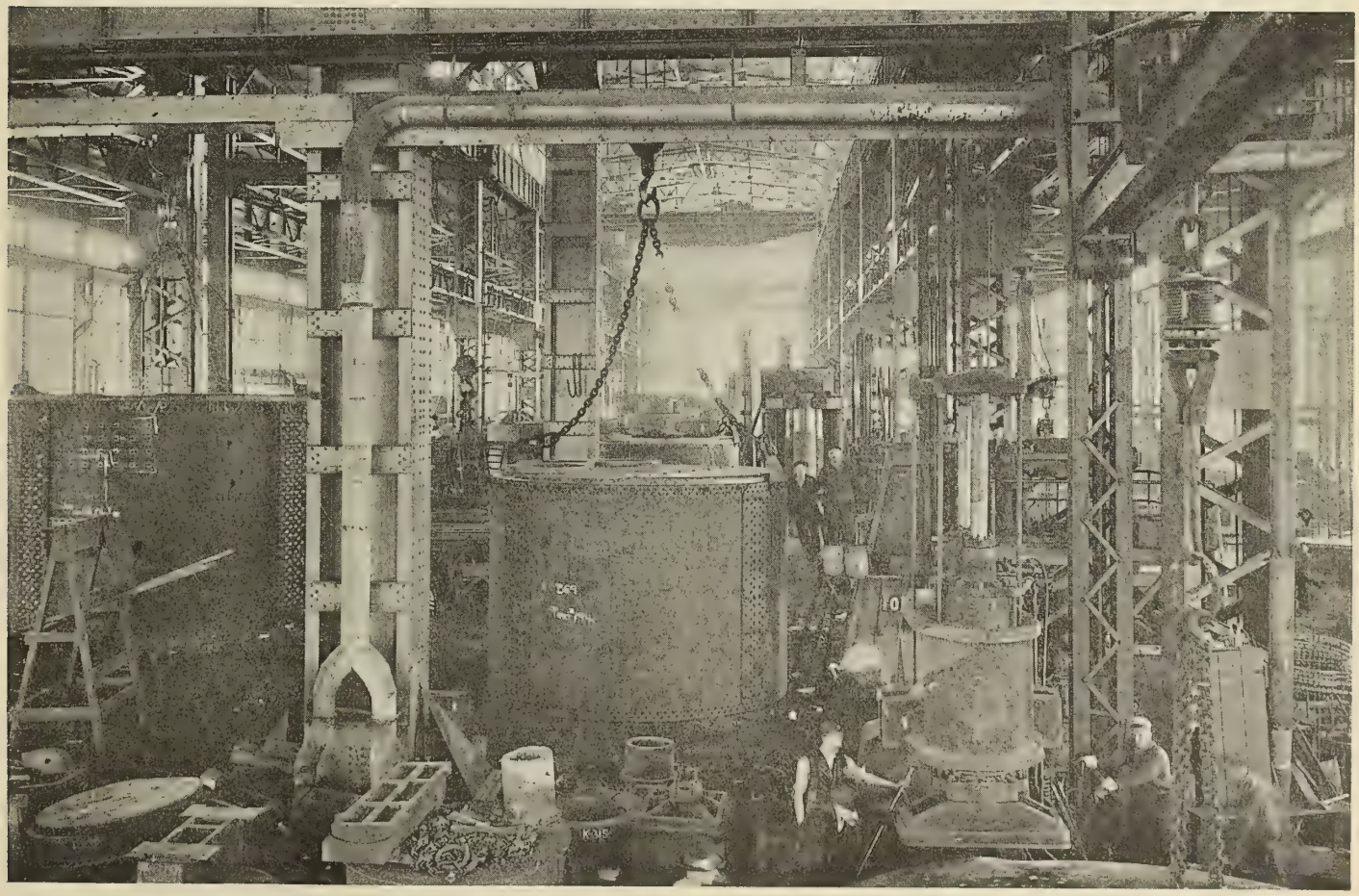


Fig. 3.—Looking East in the Main Bay of Boiler Shop at Federal Shipyard, Showing the Riveting and Assembly Departments

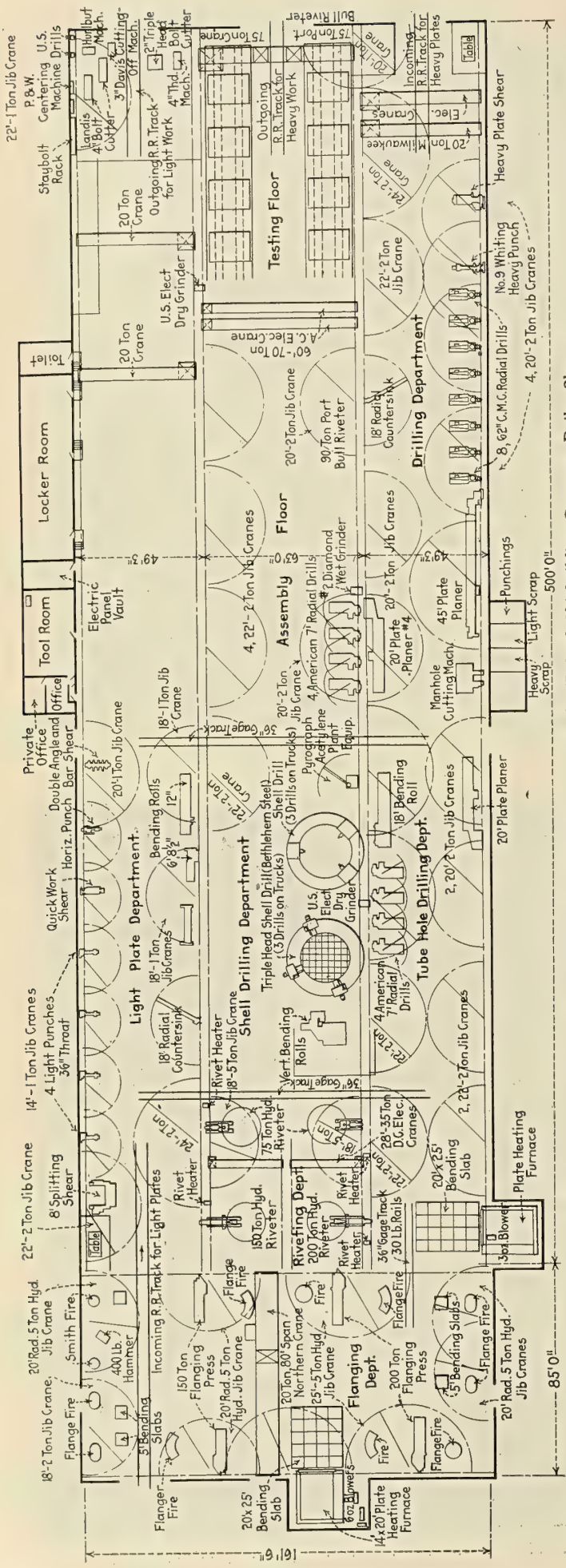


Fig. 4.—Arrangement of Departments and Tool Equipment in the Federal Shipbuilding Company Boiler Shop

take and other light plate fabrication. Production processes are carried out completely in this bay from the plates which enter the plant at the west end to the finished product which is taken from the plant on railroad trucks at the east end.

Machine Equipment of Plant

Power at 13,000 volts is supplied to a central sub-station in which current is transformed, converted and distributed to the entire shipyard. The boiler shop uses 400-volt, 3-phase, 60-cycle alternating current as well as 230-volt direct current. All electric cranes are operated at 230 volts. The lighting current is 110-volt. The oxy-acetylene and electric welding processes are used extensively in the shop on both boiler and plate work. Flanges on heads and tube sheets are trimmed with the pyrograph, an automatic oxy-acetylene cutting machine specially designed for this class of plate work. The radiograph is used for making circular and irregular cuts in plates. A special feature of the shop is the jib crane equipment, which consists of nine hydraulic and thirty-eight hand jib cranes of from 1 to 5 tons capacity and with radii of action from 14 to 24 feet. The shop is piped for compressed air, which is used at a pressure of from 90 to 100 pounds. Hydraulic pressure of 1,500 pounds is available for operating the flanging presses, bull riveters and other hydraulic machinery.

The east bay is served by two 20-ton Milwaukee electric cranes which handle material the length of the shop as far as the flanging department. Ranging along the south side of the south bay there are a set of heavy plate shears, a number 9 Whiting heavy punch, eight 62-inch radial drills, a 45-foot plate planer, a manhole cutting machine and a 20-foot plate planer. In addition, this bay contains one 18-foot radial countersink, a second 20-foot plate planer, a set of 18-foot horizontal bending rolls and four American 7-foot radial drills which are used for drilling tube holes and the like. A 20-foot by 25-foot bending slab is also located in the north bay immediately in front of a 14-foot by 20 foot plate-heating furnace in which the heads are annealed. The flanging department at the west end of the plant is served by one 20-ton, 80-foot span, Northern electric crane. Two 200-ton flange presses which will turn a 12-inch flange on 1½-inch plate and two 150-ton hydraulic presses are installed here. This department also has one 400-pound hammer, a 14-foot by 20-foot plate heating furnace and a 20-foot by 25-foot bending slab, as well as five 5-foot bending slabs and ten flange fires.

In the riveting department there are two 75-ton hydraulic riveters one 150-ton and one 200-ton riveter; the latter has a gap of 14 feet 6 inches and a stroke of 12 inches. Rivet heaters are located adjacent to each riveter. In addition, two 90-ton portable riveters are available in the shop wherever they are needed.

This department is served by two 28-foot span, 35-ton cranes. The arrangement of the rails for these cranes permits the full span cranes of the main bay to drop material within the reach of the two cranes in the riveting department, so that the main cranes are released for other work, where in most shops they are utilized for handling material, being worked in the bull riveters.

The remaining equipment in the main bay includes a set of vertical bending rolls for shell plates up to 162 inches wide by 1⅞ inches thick; two sets of triple-head shell drills are installed, one of which was built in the yard and the other of Bethlehem make. The latter will take shells from 8 feet to 18 feet in diameter and 14 feet long without reversing ends. A Davis-Bournonville pyrograph for oxy-acetylene cutting of flanges on heads and the like is located near the shell drills. The main bay is served by two 70-ton electric cranes which have a 60-foot span and two 35-ton trolleys, and one 75-ton Northern electric crane having two 50-ton trolleys. Several

United States dry grinders and Diamond wet grinders are located through the shop. A battery of four American 7-inch radial drills completes the equipment in this section.

In the north bay, used for light plate fabrication, the laying-out table is located on the west end, and from this point following through the department there are a set of 8-foot gate shears, an 18-foot radial countersinking machine, four light punches having 36-inch throats, one Quickwork shear, one horizontal punch, one double angle and bar shear, one brake bender, one 6-foot 8½-inch bending roll, two 20-ton Milwaukee electric cranes. The east end of this bay contains machines for making staybolts, threading stay tubes and the like. The equipment here includes one P. & W. centering machine, two United States drills, one Hurlbut machine, two Landis 4-inch bolt cutters, one 3-inch Davis cutting-off machine, one 2-inch triple-head bolt cutter and one 4-inch threading machine.

Every precaution has been taken throughout the shop to guard machine operators against accident. Locker and washroom facilities are very complete for the convenience of the men. The central dispensary service of the shipyard is always available for the men in the boiler shop as well as all of the other shops in the yard.

New Dry Dock at Gothenburg

FLOATING DRY DOCK NO. 2, recently built by the Eriksbergs Mek. Verkstads Aktiebolag, Gothenburg, Sweden, is of steel throughout of the following principal dimensions:

Length of pontoon	416 feet 6 inches
Length of wings	343 feet
Width over all	90 feet
Width between wings at pontoon deck	66 feet
Draft over keel blocks	21 feet
Height of keel blocks	4 feet
Depth of pontoon amidships	11 feet 7 inches

The lifting capacity is about 7,500 tons, i.e. ships with a carrying capacity of about 14,000 tons deadweight can easily be docked.

Construction of the Dock

The dock is built in three sections for self-docking purposes and these sections are bolted together. The middle section is docked in the two end sections and both end sections in the middle section for upkeep of the submerged parts of the dock.

The pontoon is divided into 18 watertight compartments by two longitudinal and a number of transverse bulkheads. A center bulkhead, not watertight, is fitted for taking the load of the keel blocks and also side girders and web frames are built for taking the load, when the keel blocks are removed for bottom repairs and for the bilge blocks.

The keel blocks, 103 in number, are made of oak of special design with wedges to be easily removed. Thirteen pairs of bilge blocks, which can be drawn with windlasses from the wing decks, are fitted.

Six pairs of side shores are mounted in the wings for placing the vessel in position before pumping and for shoring up the vessel when docked.

Pumping Machinery

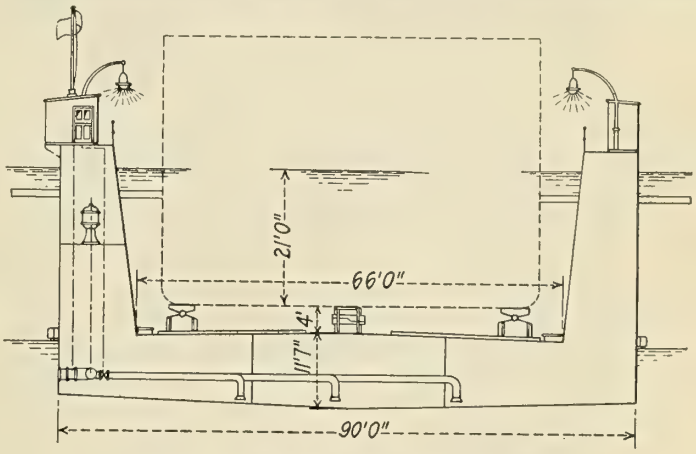
The pumping machinery consists of two vertical centrifugal pumps in the middle section, each of which is driven by a 150 horsepower electric motor, and one similar pump driven by a 75 horsepower motor for each of the end sections. The total pumping capacity is about 250 tons per minute, allowing the lifting of an 8,000-ton deadweight vessel in about 50 to 60 minutes.

The valves for all compartments are controlled from a controlling house on one of the wings where also gages, showing the height of water in the separate compartments, inclination and sagging indicators are mounted.

One electric driven tank-filling pump with a capacity of 150 tons per hour is placed on the motor deck beneath the controlling house. Four-inch pipes for compressed air are fitted along both wings at the pontoon deck for the various repair tools.

In one end of the dock a 15-ton electric crane is mounted for lifting propellers and repair materials ashore.

The motors are built for three-phase alternating current, 380 volts, 25 periods, the power being delivered to a separate transformer station on shore from The Trollhättan Falls



Section Through New Swedish Dry Dock

near Gothenburg. Here, also, the air compressors for the dock are placed.

The new dock is anchored alongside the first floating dry dock which has a capacity for lifting vessels up to 3,200 tons deadweight. The first ship was successfully docked in the new dock on February 4. With the addition of this new dock the possibilities of carrying out ship repairs at the yard are greatly increased, as the dock can accommodate any of the cargo vessels coming to Gothenburg.

Notes on Operation of Turbines*

BY E. H. B. ANDERSON†

1. When starting up new installations, it is a good plan to run the turbines disconnected up to about 20 percent above full speed revolutions, and in naval work this is standard practice.

2. I advise shutting down instantly when a bearing shows signs of heating, or if vibration begins to occur, or if a bearing shows that there is not a steady flow of oil passing through.

3. Many troubles with turbines are caused by improper drainage, and if water in bulk is kept out of the exhaust wells of the casings and oil is kept flowing to the bearings, then the engines will run well.

4. Water coming over to the turbines, due to boilers priming, will not cause blade stripping, but sediment, etc., will probably choke the blading of the low pressure turbine.

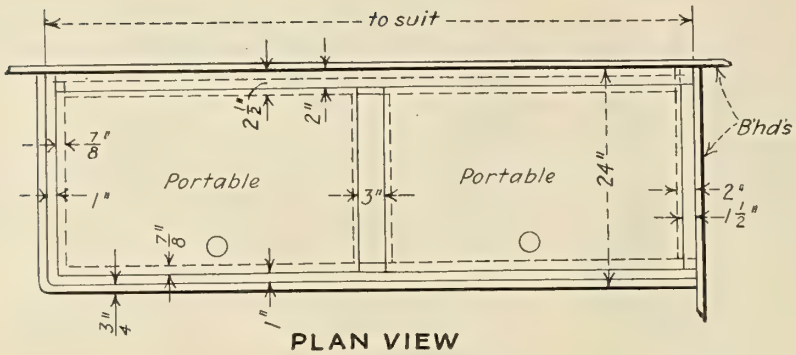
5. As a general rule, never use water on bearing caps to cool same, and it is much better to shut down and open up bearings for examination. When water is used on bearing caps, place bagging or waste on the metal and allow the water to trickle over the waste. In this way water will not find its way over to the steam belts of the turbine casings.

* From a paper on "The Parsons Marine Steam Turbine" read before the Ocean Engineers' Beneficial Association No. 80, New York.

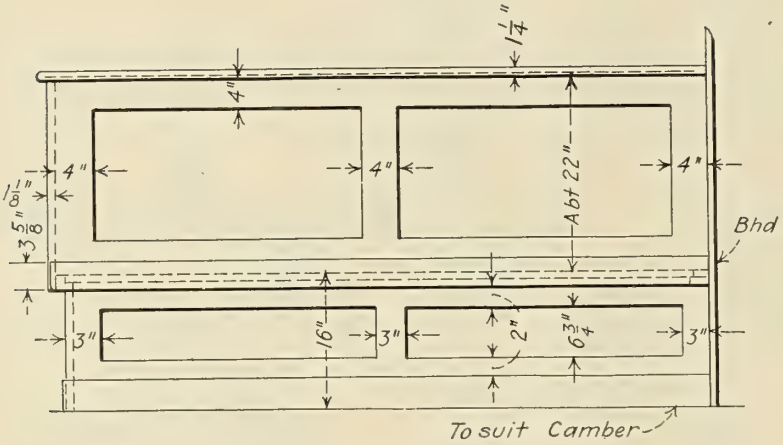
† Parsons Marine Steam Turbine Company, New York.

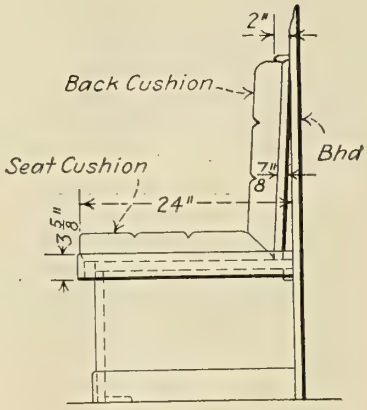
Ship Joiner Plans

Transoms

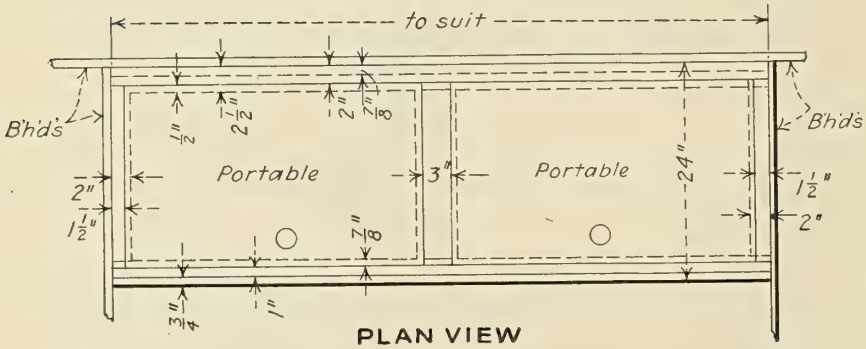


TYPE "A"
One End Open

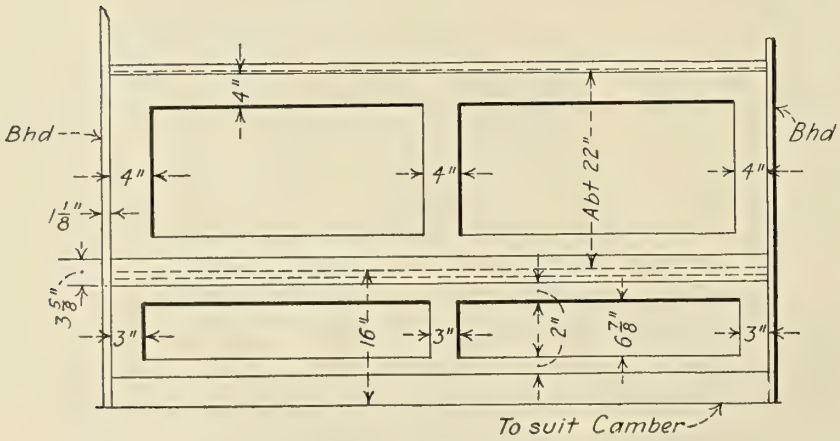


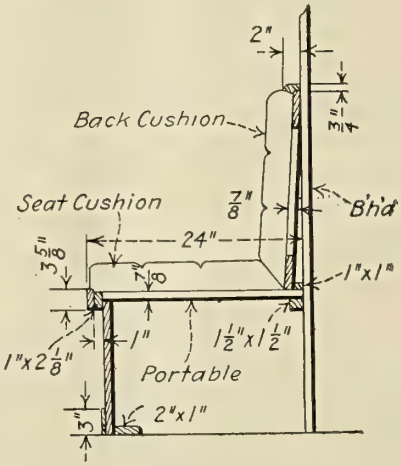


NOTE: *Exact Size of Cushions to be taken from Work.*



TYPE "B"
Both Ends Closed in





The Naval Architects' Meeting in London

Brief Review of the Papers and Discussion at the Annual Spring Meeting of the Institution of Naval Architects

BY C. H. PEABODY, DR. ENG.

AS Great Britain is a leader in naval and maritime construction the recent meeting of the Institution of Naval Architects in London is notable not only for the variety and importance of the papers presented, but also for the assemblage of the leading men in the profession and practice of shipbuilding.

With so much important material at hand only a brief review can be attempted here; American shipbuilders will find much to read and ponder when the full proceedings are available. Perhaps certain side lights will be found as illuminating as the regular proceedings. For example, the report of the Council showed a subscription of $7,000 for the past year to the research fund of the William Froude Tank at South Kensington, a tank established by the generosity of Mr. Lanow. The main business of this tank is the investigation of general problems for which governmental and commercial tanks have scant leizure.

German Naval Construction

The first two papers read were somewhat similar in nature relating to German naval design. The first, by the Director of Naval Construction, Sir Eustace T. d'Eyncourt, was entitled "Notes on Some Features of German Warship Construction," and the second, by S. V. Goodall, on the "Ex-German Battleship *Baden*." Mr. Goodall's description of the *Baden* deserves special mention for completeness and excellence. From these papers and their discussion was drawn the conclusion that except in certain details the British led in the construction of all classes of warships, including submarines. A more important conclusion for us is that the sea is and will be dominated by the battleship, in spite of the predilection of certain "ancient mariners" for submarines and air craft only. The submersible battleship of which much was heard during the war appears to be and probably will remain a myth.

The paper by R. J. Walker and S. S. Cook on "Double Reduction Gears" is most opportune and most encouraging; the fact that some American gears built during the war were unsatisfactory was not considered important; inexperience and haste were responsible. This paper was published in the May issue of this magazine, and need not be discussed here.

Strength of Ships

Three papers were concerned with strength of the ship or its parts and may be discussed together. One was by W. R. G. Whiting on the "Strength of Submarines," another by A. M. Robb on "Deflections of Bulkheads and of Ships," and the third by Professor T. B. Abell on the "Framing of a Ship."

Taking the last paper first, we have here a radical proposition that appears to lead to a considerable reduction in the material that must be worked into a ship. The author starts with two propositions concerning thin plating divided into rectangular panels, with the conclusion that if one system of frames is spaced three times as far apart as the other it lends but little additional support to the plate. So brief a statement of Professor Abell's principles is, of course, incomplete and would be misleading if we proposed to apply it ourselves, but it may enable us to appreciate his proposal to use only transverse framing in the hull of a freighter. He raises the question whether longitudinal girders may in such case be dispensed with? Can we leave out center girders, side keelsons, margin plates and bilge keelsons? Calling to mind that iron ships were built on the experience of wooden shipbuilding and that the construction of steel ships has never broken away entirely from tradition, the answer to this question can be had only after a radical reconsideration of all the habitual methods of steel shipbuilding; one wonders where modern longitudinal framing comes into such a scheme.

Strength of Submarines

Jumping back to the first paper of the trio, by Mr. Whiting, we find that it gives a thorough discussion of the stresses in the framing of submarines, which are due mainly to the hydrostatic pressure at maximum allowable submergence, for which purpose a fairly complete analysis of elliptical forms has been worked out.

The advantage claimed for his theory is that the relative effect of variations in the design can be readily predicted; as compared with Dr. Bruhn's more general method, based on the theory of least work, the processes are visible and the actual calculations are less intricate and more accurate. The same remark applies to the comparison with Professor Hovgaard's analysis, based on the principle of continuity. Mr. W. E. Noble in discussing the paper gave his opinion that the safe-diving depth of submarines is likely to increase with a linear dimension, and that there must be a natural limit on size. As a side light we may ask what influence this matter may have on the possibility of designing submersible battleships?

Deflection of Framing

The other matter of deflections of the framing of ships and their parts we shall always have with us. This is because the statement of our problem always remains indefinite. A bridge engineer may know or may assume a definite loading; the one radically indefinite factor being wind pressure. He may be reasonably confident of his anchoring. The ship designer finds for the general framing of the ship only a conventional method of loading of which he can be confident only that it never will occur in service. The loading of bulkhead frames can be neatly stated and it may so happen after an accident to the ship, but he can have no confidence in the end security of his girder. Now as to what really happens, we know that the ship's framing will be loaded some way in service, and if deficient the framing or fastenings are likely to show up any insufficiency. A ship that is lucky may never have a stress on its bulkhead frames and we have nothing to depend on except incomplete calculations and insufficient experiments. This preamble will show the importance of the paper by Mr. Robb, since he reports the results of investigations of deflection curves of bulkead stiffeners and of ships.

Mr. Robb concludes that the beam theory applies to the case of the bulkhead stiffener subject to the assumption of about 60 percent constraint at the ends, a stress of 8 tons per square inch and an effective width of plating equal to about 25 times its thickness.

Deflections of Ships

The author says that the deflections of ships for the purpose of determining the modulus of elasticity have rarely been made. The discussion of such as have been made are therefore the more important; this applies to this part of Mr. Robb's paper and to the conclusions he draws. There

are two items that come into the discussion of the deflection of the structure of a ship: (1) Deflection due to shear and (2) slipping of riveted joints. Now ships do not show permanent set as would occur did the riveted joints slip, and experiments on riveted joints do not show slipping until they are ready to fail in the testing machine. On the other hand the shear on a ship is borne chiefly by the plating, which is relatively thin, and the discrepancy between observed deflection and deflection computed without taking account of shearing may reasonably be charged to that omission.

Life Saving Requirements

The disaster of the *Titanic* brought a demand by public opinion that ships be made safe or at least safer, and that boats enough be carried for passengers and crew. Two papers presented at the Institution of Naval Architects deal with the attempts to meet these requirements. They are: "Life Saving at Sea," by E. W. Blocksidge and "Spacing of Bulkheads," by K. G. Finlay.

Since ships in service cannot be reconstructed, and since new methods of construction demand careful consideration, the investigation of the question of the safety of the ship has proceeded in an orderly manner and has resulted in the "factorial" system of watertight subdivision recommended by the International Convention. Though the leading naval architects and shipbuilders of all nations served on the convention, and though their recommendations were carefully matured, experience showed that much was left to be desired. Last summer a paper was presented by Sir Westcott Abell, the chief surveyor of Lloyd's, making certain suggestions, and now the present writer proposes a new method which he calls "odds on." In the discussion certain difficulties arising from attempts to apply the convention recommendations were reported, especially for freighters, but the general opinion appeared to be that those recommendations should be modified rather than replaced.

Lifeboats

The matter of ships' boats has received very different treatment with less satisfactory results. Legislators could and did require that all ships should carry boats enough for passengers and crew and shipowners had to meet the letter of the law as best they could. The first effect was to clutter the decks of passenger ships with all kinds of boats, real boats and collapsible boats, with little attempt to determine whether the boats could be launched or what they would be worth if that were possible. Immediately, inventors got busy devising all kinds of launching apparatus; some of them were good and have been extensively installed. The design and construction of lifeboats have been greatly improved.

Recommendations

The paper by Mr. Blocksidge brings together the experience of mariners under the new régime and presents recommendations which he thinks will give the greatest chance of saving life in case of an accident at sea. In case of foreign-going passenger ships he offers the following recommendations: (a) Only such lifeboats to be carried as can be attached to or stowed immediately under davits at the ship's side. If necessary, further equipment to be installed in the form of buoyant apparatus that can be launched without lowering apparatus. (b) The abolition of open lifeboats without outside buoyancy and of wooden pontoon life boats unless fitted with internal air cases. (c) All lifeboats to be fitted with hand pumps. (d) The extended use of motor lifeboats fitted with wireless telegraphy. (e) Towing facilities to be provided. (f) Provision of emergency lighting apparatus. (g) Rope ladders secured and stowed at the ship's side. Other recommendations are made, but those quoted are sufficient to indicate the trend of the paper.

In the discussion of the paper attention was called to the difficulty of properly drilling enough of a ship's crew to handle the boats, and also to the fact that buoyant apparatus offered little shelter and was liable to be overcrowded and to capsize. Lifeboats that got away from ships, even if overloaded, usually saved their occupants.

Among the papers were two which give results of investigations and experiments, which received comparatively little attention because solid constructive work is not sensational; a long discussion of these papers may not be necessary because those who want to use the information will get it first hand.

Use of Tallows in Launching

The first of these two papers, by J. J. King-Salter, presented "Experiments on Tallows Used for Launching Ships." Only natural tallows or mixtures with commercial stearine were made. The author premises that there should be a layer of tallow on the standing ways, a thinner layer on the sliding ways and lubricant between. The tallow should stand up under load and stick to the ways, not forming the chief lubricant, but remaining intact after the launch. But such tallow cannot be recovered for future use, as remelting changes its properties. Lubricants used have been slurry, fish oil and soft soap; all tend to affect the tallow. The best lubricant proved to be soft soap mixed with a certain petroleum oil. Since the tallow must carry a considerable load only high-grade material should be used. The hardness can practically be controlled by the proportion of stearine and should be adjusted to the expected temperature at the time of the launching of the ship.

Balanced Rudders

The second paper of this group has a special interest in that Captain Maurice E. Denny took his bachelor's degree in naval architecture in this country. His paper is on "The Design of Balanced Rudders of the Spade Type." The paper presents a combination of computations, experiments on rudders attached to models in the trial tanks, and tests on shipboard. Only a few conclusions can be quoted here. They are: (a) the normal pressure increases at a less rate than the square of the speed; (b) going astern gives a larger torque than going ahead at the same speed, and even though the stern speed is less it is likely to determine the size of the rudder stock; (c) though final conclusions require tests on board ship, the methods of variations of torque are best investigated by aid of models. It seems hardly necessary to point out that computations of stress in the rudder stock involve bending and torsion. This paper gives authoritative information which is much needed, and which has hitherto been lacking.

Standardized Data for Airships

The last paper to be considered is one on the "Stanardization of Data for Airship Calculations," by H. B. Wyn-Evans, who defines the reasons for arriving at the standards used, illustrates their applications, and finally refers to some formulae for making direct comparisons between various classes of ships.

Owing to the effect of altitude on the engines, standardized trials are assumed to be at the altitude of 2,000 feet for rigid ships and 1,000 feet for non-rigid ships. There are four speeds usually quoted for airships: (1) maximum speed on trial; (2) normal full speed, being 0.9 of the foregoing; (3) cruising speed, 0.8; (4) comparison speed, defined as 40 knots. There are two methods of determining speed; (1) on a measured course, and (2) by aid of a Pitot tube surrounded by a stream-line body. Experiments tend to show that the layer of air affected by an airship is relatively thin and well defined.

The author of the paper claims that airships can now be designed and constructed with perfect confidence.

Free Zones in Ports

BY WALDON FAWCETT

Incident to the general revision of the tariff upon which the Congress of the United States is now engaged, there has come a sharp revival of interest in the proposal to establish and maintain foreign trade zones in ports of entry of the United States. The movement for the extension of American commerce and the ambition for the upbuilding of the American merchant marine have contributed to the agitation of the subject and shipowners and operators are directly as well as indirectly interested.

FOR some time past there have been pending in the national legislature bills designed to create in American ports what might properly be designated "neutral" zones. The Committee on Commerce of the United States Senate manifested considerable interest in the proposal coincident with the framing of the Merchant Marine Act of 1920 and such was the spirit of agreement between Republican and Democratic members that, for a time, it appeared that a favorable report on the measure would be forthcoming ere the adjournment of the 67th Congress. In the press of issues of more immediate insistence this question of policy was passed on to the present Congress.

If the creation of foreign trade zones would prove as beneficial as is claimed in stimulation of the business of the American merchant marine it is most unfortunate that the proposal is saddled with a name that creates instinctive prejudice. For the appropriate designation "foreign trade zones" is comparatively little used. Rather it is the fashion in the United States to refer to the prospective neutral areas as "free zones" or "free zones in ports." The word "free" is damning. Radical and rabid protectionists and the tireless protective tariff "lobby" at Washington have encouraged the idea that "free zone" is synonymous with free trade to such an extent that it is extremely difficult for the proposition to obtain a fair and unbiased hearing before Congress. That the project has made headway in the face of misconception and misrepresentation is strong evidence of the desire to invoke, in aid of American shipping, this instrumentality of international trade.

No less impartial an authority than the United States Tariff Commission has declared that the use of the word "free" in connection with "port" or "zone" is apt to be misleading, since the term has no relation either to port charges or to any policy of "free trade" or "protection," as these terms are commonly applied in the United States. Essentially, the foreign trade zone is an alternative and supplementary device for the system of bonded warehouses, bonded manufacturing warehouses and the entire drawback system with which the public is familiar. Particularly does the device promote transshipment in foreign trade, which circumstance establishes instantly its contact with the shipping interests.

Definition of Free Zone

A free port or free zone has been described as a place, limited in extent, that differs from adjacent territory in being exempt from the customs laws as affecting goods destined for re-export. In more detail, a free zone may be defined as an isolated, inclosed and policed area, in or adjacent to a port of entry, furnished with the necessary facilities for lading and unlading, for supplying fuel and ship's stores and for storage and reshipment. As regards customs duties there is in this reserved area, freedom and immunity, unless or until the imported goods enter the adjacent domestic market. Within the posted trade preserve goods may be landed, stored, mixed, blended, repacked, manufactured and reshipped without the payment of duties and without intervention by customs officials.

For the domestic trade of the United States the establishment of foreign trade zones would have no significance. Nor would the system be likely to either increase or diminish the volume of goods of foreign origin entering this country. But unquestionably the plan would lead to multiplication of the volume of international commerce that would "pass our way" and in equivalent proportion would it place an increased measure of carrying business within the reach of American shipowners. Frequently it would be advantageous if goods en route from one part of the world to another could tarry in the United States for conditioning or pending the relief of port conditions at ultimate destination, as, for example, in the case of the recent congestion at the port of Havana. Even more often would foreign goods be routed via the United States—preferably in American ships—if there were facilities whereby the alien wares could "wait over" and be combined with United States products destined for a common destination. Every service of this type would be feasible if neutral zones were in being.

Drawback System

While the nominated program of foreign trade zones has been hailed in some quarters as an innovation in so far as the United States is concerned, as a matter of fact the past policy of the United States has not been unfavorable to the form of commerce that the so-called free zone is designed to promote. Indeed, the drawback system which allows repayment of customs duties when goods are re-exported and the bonded warehouses which afford duty-free storage for goods intended for re-export exemplify in kind the basic principle of the neutral zone at a port of entry. It may well be asked in this connection why the instrumentalities mentioned do not serve all the practical purposes of a foreign trade zone. The answer is that the devices at hand have proven totally inadequate for the free flow of international commerce past our gates. Defects in the systems have been in part responsible but hardships have also been imposed upon traders by faulty forms of administration.

For example, recourse to the bonded storage warehouse can not aid in expediting the entry and clearance of shipping or the handling of merchandise because vessels must submit to the same formalities and requirements whether they bring dutiable goods or goods to be placed in bond, and the goods themselves, whatever their destination, must be valued, sampled, weighed and tested before removal from the dock. Much of the delay incident to the assessment of duties on imports for domestic consumption is equally imposed on goods destined to be reshipped. It is obvious that the practice and regulations governing the entry of dutiable goods en route should be of the utmost simplicity in the case of a ship landing part of its cargo at an American customs port and desiring to continue its voyage with the remainder of its cargo.

Restrictions on Handling

One of the worst features of the present bonded warehouse system is that the handling, sorting, mixing or repacking of goods is prohibited. Only where serious damage is threatened

can the original package be opened, and even then it must be done by special permission and under customs supervision. This limitation utterly defeats that consolidation of shipments which is so conducive to the prosperity of the American merchant marine. Even more stringent and hampering are the regulations which virtually nullify the usefulness of the bonded manufacturing warehouse. The drawback system, the third of the present devices, is excellent in theory but in practice it has been found anything but effective, principally, no doubt, because it is no more free than the other institutions from the delays and burdens incident to customs enforcement.

Illustrations almost innumerable might be cited to show how seriously and injuriously American shipowning and ship operating interests are affected by the inadequacy of the present bonding and drawback system. For one thing, American ships are deprived of what might otherwise be a profitable carrying trade, the transportation of rice from the Orient to Latin America. The rice milling industry of the United States is the most efficient in the world in point of special machinery and equipment and skilled labor but the mills are idle a considerable portion of each year because their sole function at present is to prepare the domestic product, which is limited in quantity. Rice from the Far East, en route to Central and South America and the West Indies, would come to the American plants for cleaning and milling were it not for the expense and formalities connected with the stop-over. The Oriental rice moves in full ships' cargoes, averaging about 6,000 tons, so that it is necessary to invoke the drawback system and the time-consuming red tape involved in this system has literally strangled the trade.

Consolidated Shipments

The Latin-American trade which, just now, beckons invitingly to American shipping interests is impeded no less by our present cumbersome bonded warehouse system than by the inelastic drawback system. Merchants in Latin America, particularly buyers of all classes of wearing apparel and articles of adornment, very much prefer to purchase from houses that will assemble the specialties that are requisitioned even though the selections represent the products of a number of different countries. To consolidate shipments in respect to the wishes of the Latin-American customer involves, therefore, sorting and repacking of the foreign wares that are to accompany the United States merchandise. This is virtually impossible under the present American bonding system which does not permit the original packages received from Europe to be broken and rearranged. To such a pass have matters come that it has been necessary on occasion to ship goods from the United States to a port in the West Indies to be there repacked and consolidated with European goods before continuing on to destination.

Transshipment Trade a Maritime Index

Loss to the United States of transshipment trade must appear, in the eyes of the average shipping man, the most serious indictment that can be drawn against our present bonding and drawback system. Such has been the growth of this phase of commerce that it is calculated that a normal, annual turnover of $4,000,000,000 is involved in the operations of the leading maritime nations in assembling, transshipment and redistribution of merchandise. As has been mentioned above, manufactured goods enter to some extent into this transshipment trade, but in the main it is concerned with the raw materials of those countries that have not attained a high stage of industrial development and that are dependent on the maritime nations for the transportation of their products and the supply of their necessities.

While the transshipment trade of other leading maritime nations has been expanding steadily to the obvious advantage of ship operators and merchants the transshipment trade of the United States has declined until it is of almost insignificant proportions. It is all too apparent that the scope and extent of a nation's transshipment trade is the measure of the virility of its maritime industry. The history of the past one hundred years shows most conclusively the tendency of ocean-borne commerce to concentrate at the so-called "free ports"—Hamburg, affording a conspicuous example—and lends force to the argument of those friends of the American merchant marine who contend that it can never realize its destiny unless foreign trade zones be created at leading United States ports.

Efficient Port Facilities

Scarcely less important to American shipowners than the greater number of cargoes that would be offered would be the improvement of United States port facilities that might be expected to follow the establishment of a system of free zones. It goes without saying that the most important prerequisites of a neutral port of the kind referred to comprise adequate and efficient modern facilities for the lading and unlading of cargoes, the entry and clearance of vessels and the handling of merchandise. Specialists who have, in behalf of the Tariff Commission and at the behest of Congress, made a study of the neutral zone proposition do not charge that the representative ports of the United States are lacking in wharves, docks, piers and terminal facilities. Rather is it their criticism that these physical facilities have, with few exceptions, developed by a process of planless accretion.

A remedy, it is claimed, would be provided under the influence of neutral port conditions. Up-to-date mechanical equipment for the speedy and economical handling of cargo, which has been lacking heretofore because there was not the traffic to keep it continuously and profitably employed, would be forthcoming, it is predicted, because the steady flow of commerce passing through a free zone would put an end to the erstwhile fluctuations between slackness and congestion. Similarly, it is forecast that capital would be attracted to port installations and equipment by the certainty of profitable return from the accelerated commercial movement that would result from the operation of the free zone system. In some quarters, misgivings have been voiced as to the effect of the establishment of a foreign trade zone in a United States port upon the existing investment in cargo-handling equipment and terminal facilities. Experts who have, at the behest of the United States Government, investigated this aspect of the situation at Copenhagen and other ports where the neutral zone plan has been subjected to the test of time, insist that there is absolutely no occasion for uneasiness on this score. It is declared that even at the trade centers where the provision of free zones has been characterized by the installation of elaborate equipment, publicly financed, the development of the business of the free zone has been accompanied by material increase in the use of the previously existing and privately-owned port facilities.

In reassurance to the interests who have capital invested in the present appointments of United States ports, it has been emphasized in the discussions at Washington that the purpose of a so-called free port is not to divert business from those that now transact it but to provide for new business that, under existing handicaps, has no opportunity to develop. As for the shipping interests, and, in sympathetic degree, the shipbuilding and ship outfitting interests of the country, it would appear that they have all to gain and nothing to lose by the establishment of neutral zones at strategic points, albeit the effect might be to cause some diversion of ocean traffic from present objectives.

Simplification of Entry and Clearance

Foremost of the immediate boons to shipowners and operators of the installation of the neutral zone system would be the simplification of entry and clearance. Time lost by merchant vessels, whatever the cause, is always costly and one of the most perplexing responsibilities confronting vessel owners is that of so calculating normal or probable delays that will involve the idleness of the ship and crew as to maintain the requisite level of income and profit. Especially baffling in this process of forecasting lost motion has been the detail of figuring the delays that must logically be ascribed to customs procedure. It is a foregone conclusion that an allowance of this kind should be reckoned for every port of call but it is sheer guesswork whether the delay will be one of hours, or of days, duration.

Commenting on this particular phase of shipping operations and the possibility of correcting or reducing the evil via the instrumentality of free ports, an official of the United States Tariff Commission said that it is the free-lance operator of ships who suffers most severely from time-stealing customs procedure. Officials of regular steamship lines or operators of vessels that habitually traverse given trade routes are likely to acquire a familiarity with the regulations and administration in their particular environment that enable them to reduce to the minimum, say to terms of hours, the delay incident to entry and clearance. But the operators of tramp steamers and independent tonnage of all classes pay heavily in elapsed time for the technicalities or formalities of making entry and they are liable to pay in a double sense, if penalties are incurred through inadvertence or a failure to understand or correctly interpret the regulations. Within neutral zones entry and clearance formalities are reduced to a minimum with the object of allowing prompt docking, uninterrupted discharge of cargo, quick lading and an early clearance.

Equalization of inbound and outbound traffic is a promised blessing no less to be esteemed by the ship operator than the one above enumerated. The need of better balance of tonnage—the assurance to owners that they will find cargoes both in and out bound—has been one of the deficiencies that has held back the development of the American merchant marine and any panacea that promises to correct this is certainly worthy of attention. Peculiarly pertinent at this juncture, when so many of the nations of the world are engaged upon or have in prospect revisions of their tariff systems, is the contention that the inauguration of a system of neutral zones would free the transshipment trade from the unsettling effects of tariff changes. Shipping interests would, to a great extent, be spared that chill which strikes the industry whenever a new national tariff policy is in the making and the whole commercial atmosphere is charged with uncertainty in consequence.

What Are We Carrying?

BY "OLD SCOTCH"

It is the basic desire for increased comfort and luxury that is one of the main supports of traffic on the seas. The crude necessities for sustaining life are produced in almost every country in sufficient amounts to supply the local demands. In the whole progress of civilization the luxury of today becomes the necessity of tomorrow, hence we in America will become increasingly dependent upon our sea-borne commerce to dispose of our surplus of manufactured articles. In thirty years the value of our manufactured goods exported from our shores has increased from $403,737,000 *to* $5,349,327,000, *or over twelve-fold. It is therefore, so far as our merchant marine is concerned, of the greatest interest to discuss what we may expect to carry in our ships.*

THE basic reason for ships is the transportation of goods and persons from and to the various ports of the world, to accomplish the interchange of necessities to maintain our existence and gratify our desires for pleasure insofar as travel by sea is concerned. Primitive man needed but few things which were not produced in his immediate vicinity, but in the complex civilization of today our needs, real and imaginary, are so diversified that seemingly, at least, every nation produces something which every other nation thinks it needs. The basic needs of mankind are food, raiment and shelter, hence the commodities which fulfill these desires must naturally form the great bulk of international trade. The demand for luxuries and comforts, ever increasing in the human mind, tends to accelerate international trade, as the people of one community gradually learn of new means for gratifying these desires possessed by other and quite often distant communities.

We have so rapidly gone from an agricultural to a manufacturing country that our shipping facilities become more than ever vital to our national well-being. People generally buy food products because they have to have them. On the other hand, manufactured goods must be sold in the competitive markets of the world, and we must have our own means for selling. At the recent annual meeting of the United States Chamber of Commerce, Secretary Hoover made the emphatic statement that if we are to succeed in selling our manufactured goods abroad, we must have our own native-born salesmen. Coming from such an authentic source on world commerce, the sentiment was loudly applauded. He might have gone further along the same line and stated that back of the salesmen must be American ships manned by Americans.

The Trend in Exports

American ingenuity and love of comfort and luxury will ever tend to produce articles for export when people abroad hear of the American standards of living. The cheap automobile, once a luxury and now a necessity in the daily life of the people, will probably always be a leading article of American export. The demand for our labor-saving agricultural instruments is constantly increasing, as farmers of other countries learn of the increased production and greater ease of operation by their use.

Unfortunately for shipping data most of our statistics on the subject of foreign commerce are given in dollars instead of tons. While money is the crux of our prosperity, shipowners must necessarily be greatly interested in the weights of commodities to be carried on the seas. As a matter of fact America is peculiarly fortunate in the matter of bulk cargoes.

Coal and petroleum probably form over half of all sea-borne traffic, when weight alone is considered. Up to very recent times two-thirds of all the petroleum in the world has been produced within our own borders, and 58 percent of all the actual coal reserves in the world are located in North America. Hence so long as these producers of power and comfort are demanded by mankind, America will for many years have a preponderating portion of these commodities to ship by sea. With two-thirds of the production of the world's supply of cotton within our own borders, that too will form an important item of sea-borne traffic.

Character of Imports

The return from the transportation of all these goods is what concerns shipowners most vitally. Our exports, consisting so largely of such bulky items as coal, oil and cotton, will probably always continue to exceed the weights of goods imported. Our imports will be less bulky but of more concentrated values. Hence a leading statistician has recently announced that an approximate method of determining the cost of our sea freights is to take 7 percent of the value of our exports and 3 percent of the value of the imports, which will be the financial returns to shipowners and operators. Last year the indirect returns for ocean freights to Great Britain, the leading maritime nation of the world, amounted to over $1,600,000,000. With our enormous volume of exports and imports, the monetary value of transporting our own goods in our own ships may well be imagined.

The lack of production in the war devastated European nations is keenly felt in our imports at the present time, and in all probability will continue for several years yet to come. Many American ships are returning to our ports in ballast as a direct result of this condition of affairs. In this connection it is interesting to note the inward manifests of ships now arriving at the port of New York, which are fairly indicative of our national import situation. We are so self-contained as a nation that a perusal of the various manifests will bear out my contention that luxuries instead of real necessities form a very important part of our sea traffic.

Luxuries From Abroad

A steamer arriving from Havre, France, brings in a cargo largely composed of such items as silks, trimming, ribbons, toys, musical instruments, perfumery, clocks, fancy cheeses, tulle, church ornaments, skins of animals, feathers, cigarette papers, embroidery, chinaware, medals and beads, jewels, fancy dresses, lingerie, pearls, etc., etc., most of which are to gratify the tastes of our American ladies, and which cost considerable money, but are not very bulky as ship cargoes go.

From Christiania, Norway, comes a ship laden with calfskins, fishhooks, sardines, safety matches, cheese, ammonium nitrate, etc., most of which could if necessity demanded be produced here.

From Antwerp an American ship arrived loaded with rags, brass ingots, wallpaper, books, aluminum sheets, etc., all of which does not indicate much production in plucky little Belgium.

From Piraeus, Greece, arrives a ship laden principally with olives, olive oil, figs and tobacco, and such miscellaneous items as camomile flowers, sage leaves and metallic money.

From the Bermuda Islands it is quite natural to find at this season of the year a cargo composed of potatoes, onions, celery and other kinds of spring vegetables. Owing to prevailing high rates on our railroads it is evidently cheaper to import from Bermuda by sea than to get these vegetables by rail from our own southern states.

From various Mexican ports a steamer arrived containing a cargo composed of bar lead, vanilla, coffee, quicksilver, sponges, sisal, pineapples, palm hats, goatskins, etc. Conditions are evidently not so bad in that revolution-distressed neighbor but what they can find some articles to sell to us in return for our foodstuffs and manufactured articles.

From Matanzas in Cuba comes an entire bulk cargo of sugar, which naturally forms one of our largest imports.

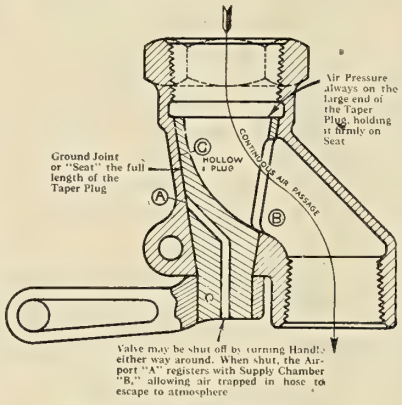
From Santos in Brazil an entire shipload of coffee is received to supply the insatiate demands of our American breakfast table. Incidentally it is claimed by importers, that only 10 percent of the enormous supply of coffee from Brazil arrives in American bottoms. Needing large quantities of our coal as they do in Brazil, it seems rather lax on our part that we do not utilize some of our idle Shipping Board tonnage to carry coal there and bring back coffee even if we do have to slash the rates to get our rightful share of this business.

Among the arrivals on this particular day was a single American wind-jammer loaded with a half million cocoanuts. For such cargoes as this it is a wonder that more American sailing vessels are not utilized. The high cost of operation of steam vessels and the comparatively low freight rates make sail propulsion look attractive, for as one prominent American schooner owner expresses it the only things a vessel uses which has not gone up in price are the trade winds and the gulf stream.

As we now have the ships of all descriptions to transact our foreign trade, we certainly need to make a study of all questions appertaining to trade and barter in order to keep our merchant marine busy and regain our national prosperity.

Cleco Pressure Seated Air Valve

The Cleveland Pneumatic Tool Company, Cleveland, Ohio, has recently brought out an air valve designed to eliminate air losses through leakage in transmission. The object sought was to construct a valve in which the air could not come in contact with the seat, thus avoiding replacement of seats, and also to utilize the air pressure as a seating agent to hold the valve plug on its seat, thus eliminating packing, gaskets, stems and springs and reducing the valve parts to three, i.e., body, plug and handle.



Section of New Air Valve

This was accomplished by using a "hollow taper plug" with the large end uppermost; the air entering at the top, passing through and out of an opening in one side of the hollow plug into the supply chamber which connects directly with the air hose without the air coming in contact at any time with the valve seat, which is the outer wall of the plug as indicated by *C* on the drawing. The long arrow shows the direction of the air in its travel through the wide unobstructed air passage of the valve which is free from any angle turns to impede its progress. The short arrow indicates the point on the large end of the plug where the air pressure is constant, forcing the taper plug against the walls of the valve body.

The valve is provided with a unique waste arrangement to allow the accumulated pressure in the air hose to escape to atmosphere when the valve is shut off as shown by air ports *A* and *B* on the drawing: this is to safeguard the operator, who, when disconnecting the hose from the valve, often receives a gush of air in the face and accidently gets scale or grit in his eyes.

Problem of the Hull and Its Screw Propeller—III*

Cavitation—Phenomena that Actual Performance Data Have Shown to Occur With Various Types of Vessels

BY REAR-ADMIRAL C. W. DYSON, U. S. N.

IT has been shown how vessels can be divided into three general types according to the form of the after body lines. They may also be divided into types according to the values of the basic slips, namely:

1. Vessels having basic slips of the first order, which include vessels having basic slips of about 13 percent and lower.
2. Vessels having basic slips of the second order, which include all vessels having basic slips exceeding about 13 percent.

These distinctions according to the basic slips are encountered with vessels of type 2, and in order to explain them attention is called to Figs. 7 and 8 (see pages 400 and 402, May issue).

Cavitation (Fig. 8)

Many years ago, on the trials of the British destroyer *Daring*, difficulty was experienced in obtaining the contract speed due to failure of the propellers, such failure being accompanied by heavy vibration. The difficulty was finally overcome by increasing the projected area of the propellers to quite a large extent. After a thorough study of the phenomenon, Mr. S. W. Barnaby, of Thornycrofts, advanced the theory that the failure was due to a lack of flow of water to the propeller caused by insufficient supply head, this failure resulting in the formation of cavities in the water in which the propeller was working. He gave the name of cavitation to this action and fixed a limit of effective thrust, 11½ pounds per square inch of projected area, as that at which cavitation could be expected to occur. Later experience has demonstrated that this limit is not correct but that it depends upon the projected area ratio; the higher this ratio the higher the effective thrust before cavitation happens. Taylor supposes that both tip speed of the propeller and effective thrust enter into the solution of the problem. By inspection of Fig. 5, curves of design, it will be noted that tip speed increases with indicated thrust and with effective thrust as the projected area ratio increases. It is also a fact that, in changing from the basic conditions of resistance, for equal powers the indicated thrusts vary inversely as the tip speeds. Therefore with a vessel loaded down very heavily beyond the designed condition the tip speeds will, as a rule, be less than the designed tip speeds and yet, as experience has taught, cavitation may occur.

It is not the intention of this paper to advance any theories as to cavitation, but rather to have the student form his own theories after having had pointed out to him the various phenomena that actual performance data have shown to occur.

For convenience in discussion the phenomena encountered where the load fraction $\frac{e.h.p.}{E.H.P.}$ is less than unity will be spoken of as cavitation of or dispersal of the thrust column of the propeller, while for those phenomena met with where the load fraction exceeds unity the term cavitation of the suction column of the propeller will be employed.

Dispersal of the Thrust Column

It has already been stated that vessels can be divided into types according to the magnitude of their basic slips and that vessels of type 2 exhibit the variations due to changes in this magnitude.

Turn now to Fig. 7. Without cavitation it has already been pointed out that to obtain the value of the apparent slip for any other than basic conditions the equation is:

$$s = S \frac{I.H.P._a \times 10^{Z_s}}{I.H.P.},$$

or $\log s = \log S + \log K + Z_s - Z_p$, where Z_s is taken from curve 1.

With hulls of type 2 at any given value of load fraction there will be a corresponding value of speed fraction $\frac{v}{V}$, at which the quality of the wake will change materially; in the cases of vessels of type 2 having basic apparent slips of the first order two changes will occur and there will be two corresponding values of $v \div V$. The first change with such vessels will be from a basic slip of the first order to one of the second order, while the second change will be from slips of the second order to cavitating slips. The first change will occur without loss of efficiency of propulsion when the value of K equals unity. When the value of K is greater than unity the change of slips will be accompanied by an increase in value of K and all the phenomena of cavitation will occur. When K equals unity the second change will be accompanied by a rapid loss in efficiency of propulsion.

When the first change occurs, if it were known what the new basic S were to be, it could be inserted in the equation for apparent slip in place of the original basic S and the values of Z_s be taken from curve 1, Fig. 7, as before. In place of making this change of basic slip, available data have given the curve marked 2, from which, using the value of the original basic S, the new values of Z_s are taken. For this curve of Z_s the values of Z_s vary as $3.09 \log \left(\frac{V}{v}\right)$.

Now assuming that when the actual apparent slip at any gross load fraction has reached the value of the basic S apparent slip conditions are on the verge of change

$$\log s = \log S + Z_s - Z_p + \log K$$
$$s = S,$$
$$\therefore Z_s + \log K = Z_p.$$

Turn now to Fig. 8. The abscissas of this figure are values of load fraction $\frac{e.h.p.}{E.H.P.}$, while the ordinates are values of speed fraction $\frac{v}{V}$. The point whose abscissa value and ordinate value are both unity is the point of basic condition, while diagonals passing through the origin and crossing the ordinate $\frac{v}{V} = 1$, at any value of $\frac{e.h.p.}{E.H.P.}$ are diagonals of effective thrust ratios, the ratio being equal to the load fraction $\frac{e.h.p.}{E.H.P.}$ at which the diagonal intersects the ordinate $\frac{v}{V} = 1$, and is expressed by $\frac{e.t.}{E.T.}$, in which $e.t.$ is the actual effective thrust, while $E.T.$ is the basic thrust of the propeller.

* Paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1920.

Lay down the curve where $Z_s = Z_p$, one of the points of which must be the point of basic condition, and it will be found that the curve marked A will follow the law—

$I.H.P._p$ or $S.H.P._p$ varies as $3.09 \log \left(\frac{v}{V}\right)$ or Z_p varies as $3.09 \log \left(\frac{V}{v}\right)$ which is the same as that for Z_s when $s = S$.

Calling the new basic slip of the second order, S_1, the ordinate of any point on A, $\frac{v}{V_1}$; the value of Z_s for $\frac{v}{V_1}$ taken from curve 1, Fig. 7, Z_{s1}; the original basic slip S the corresponding value of the ordinate $\frac{v}{V}$; and the value of Z_s for $\frac{v}{V}$, taken from curve 2, Fig. 7, Z_s,

$$\log S + Z_s = \log S_1 + Z_{s1},$$

from which for any assumed values of S_1, $\frac{v}{V_1}$ with its corresponding value of Z_{s1}, can be found a curve of values of S for a series of assumed values of $\frac{v}{V}$ (each less than $\frac{v}{V_1}$), with the corresponding values of Z_s. Taking a series of values of S_1 for any value of $\frac{v}{V_1}$, it will be found that as S_1 increases S will increase and $\frac{v}{V}$ diminish until S_1 equals approximately 21 percent, when the value of S will become constant for any further decrease of $\frac{v}{V}$.

The values of $\frac{v}{V}$ and the values of S at which the latter becomes constant are the limits at which the change from basic slips of the first order to those of the second order occurs, and this statement is borne out by all the data available. The curve of these slips is shown at the lower part of Fig. 8, while the limiting curve of $\frac{v}{V}$ is shown, marked B. For type 1 and type 3 vessels this shift of Z_s values does not occur, so far as can be ascertained, but Z_s is taken always from curve 1, Fig. 7. These two types and type 2 of first order of apparent slips having $K = 1$ pass on down to $\frac{v}{V}$ values shown by curves C, Fig. 8, before genuine dispersal of the thrust column, with consequent loss in efficiency, is encountered. These curves C have been determined from the performances of a four shaft vessel when steaming with only one propeller in use on each side of the ship, the idle propellers dragging, a slight correction having been allowed in the *e.h.p.* curve of the vessel for the increase in resistance due to these idle screws. The actual increase occurring is one that should be solved by the model tank.

Turning now to hulls of type 2 with basic apparent slips of the second order, only one change occurs in the slip conditions, and that is the change from slips of the second order to those of cavitation. These latter are augmented (similar to those of types 1, 3 and of 2 when original slips are of the first order, when $\frac{v}{V}$ is less than those of curves C, Fig. 8) on entering cavitation due to the increase in power demanded by the cavitating condition.

As the curve B is the change limit for slips given by the slip curve D, it is assumed that a corresponding change from slips of the second order to those of cavitation will occur at values of $\frac{v}{V}$ varying inversely as the ratios $\frac{1 - S \text{ of } B \text{ curve}}{1 - S \text{ of 2d order}}$ and by assuming different values of these slips of the second order curves of cavitation limits varying from $S = .27$ down to curve B have been laid down.

For hulls of type 2 curve B has been checked by the performances of submarines of the Holland type, while the curves for slips of the second order have been checked by submarines of the Lake type. These two types usually are radically different in the forms of hulls and in the arrangement of their propellers. Vessels of the Holland type require the use of the surface draft in obtaining the *S.B.C.*, while only one-half diameter of the hull is used in determining the ratio $2L.A.B. \div H$, and those of the Lake boats, while obtaining the *S.B.C.* in the same manner as for the former, use a much greater value than one-half diameter of hull in obtaining the after body length ratio; in fact, for both types the H in the ratio $2L.A.B. \div H$ equals the height of the point of the stern above the base line.

This results in a much greater value for the after body ratio of the Hollands than for the Lakes, with a corresponding reduction in the basic slip values. Due to the position of the propellers in relation to the hull and also to the peculiar form of hull, the Lake boats have a shifting value of K depending upon the length of the vessels until this length equals or exceeds 230 feet, when K becomes unity for all surface conditions of speed. For all lengths of vessels of the Holland type operating on the surface, K has a constant value of unity.

When vessels of either type are running submerged it becomes necessary to bring the diving rudders into operation in order to maintain proper balance, and the additional resistances introduced by the resistances of the diving rudders appear to vary with the speeds, disappearing entirely at 10 knots with boats of the Lake type, but reappearing at speeds above 10 knots. With vessels of the Holland type the re-

VALUES OF K FOR SUBMARINES

Lake Submerged

v	6	7	8	9	10	11	12
L.W.L.	K						
150	1.35	1.24	1.14	1.05	1.0	1.1	1.4
160	1.30	1.20	1.12	1.04	1.0	1.09	1.34
170	1.25	1.17	1.10	1.04	1.0	1.07	1.28
180	1.20	1.13	1.08	1.03	1.0	1.06	1.22
190	1.14	1.10	1.06	1.02	1.0	1.04	1.16
200	1.09	1.06	1.04	1.015	1.0	1.025	1.11
210	1.05	1.035	1.02	1.01	1.0	1.02	1.05
220	1.00	1.00	1.00	1.00	1.0	1.0	1.0
230	1	1	1	1	1	1	1
250	All below=unity up to 12 knots.						
260							
270							
280							
290							
300							

Lake—Surface

v	6	7	8	9	10	11	12	13	14	15	16	17
L.W.L.							K					
150	1.17	1.13	1.085	1.04	1.00	1.027	1.095	1.14	1.19	1.23	1.29	1.45
160	1.145	1.12	1.075	1.038	1.00	1.023	1.083	1.112	1.17	1.21	1.25	1.35
170	1.125	1.097	1.064	1.033	1.00	1.02	1.073	1.105	1.143	1.175	1.215	1.3
180	1.105	1.082	1.055	1.03	1.00	1.019	1.062	1.089	1.12	1.147	1.18	1.25
190	1.086	1.068	1.045	1.025	1.00	1.017	1.05	1.072	1.097	1.12	1.148	1.2
200	1.067	1.052	1.036	1.02	1.00	1.013	1.04	1.055	1.075	1.09	1.11	1.15
210	1.047	1.037	1.025	1.015	1.00	1.01	1.03	1.04	1.052	1.063	1.075	1.1
220	1.025	1.020	1.013	1.01	1.00	1.01	1.015	1.02	1.03	1.035	1.04	1.05
230	1	1	1	1	1	1	1	1	1	1	1	1
250												
270	All below = unity until $\frac{v}{\sqrt{L}} = 1.12$, when there may possibly occur a rapid increase in K, reaching 1.22 at $\frac{v}{\sqrt{L}} = 1.19$ and											
270												
280	rising rapidly.											
290												
300												

Holland Type
Submerged only as $K = 1$ for Surface

v	5	6	7	8	9	10	10.5	11
L.W.L.				K				
150	1.275	1.385	1.395	1.395	1.395	1.375	1.34	1.25
160	1.12	1.23	1.25	1.25	1.25	1.21	1.19	1.07
170	1.04	1.12	1.14	1.14	1.14	1.1	1.09	1.0
180	1.0	1.04	1.06	1.06	1.06	1.03	1.025	1.0
190	1.0	1.005	1.01	1.00	1.00	1.00	1.00	1.00
200	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

All greater lengths of L. W. L. have $K = 1$.

These K's are not true power augments, but are genuine variable changes in resistance, and therefore are not treated as the K in Problem 1 in the determination of cavitation.

sistance due to the influence of the diving rudders appears to reach a maximum at 7 knots, remaining practically constant in its effect on K until 9 knots is reached, when it begins to fall rapidly.

In both types of vessels the value K at any speed appears to depend upon the length of boat; in the case of the Holland boats K in the submerged condition becomes unity when a load waterline length of 200 feet has been reached, while with the Lake type the value of unity is not reached until a load water length of 230 feet has been attained.

These values of K for both types of vessels are given in the tables.

To illustrate the changes occurring with type 2 vessels with true $K = 1$, in passing first from slips of first order to slips of the second order and second from slips of the second order to cavitation, analyses of the performances of two vessels are given. The first vessel used is a Holland submarine having a basic slip of the first order, the problem being divided into two parts: (*a*) surface condition; (*b*) submerged condition:

VESSEL C

Hull

$L.L.W.L. = 268.57'$
$B = 22.16'$
$H = 14.16$ (surface)
$H_1 = \frac{B}{2} = 11.08'$
Nom. $B.C. = .459$
$\frac{B}{L.L.W.L.} = .0825$
$\frac{H}{B} = .684$
$L.A.B. = \frac{L.L.W.L.}{2}$
$\frac{2L.A.B.}{H_1} = 24.24$
$S.B.C. = .451$
$S = .125$
$K = 1$

Propeller

D ..... 7'
P ..... 6.25'
Blades 3
Projec. form. Standard
$\frac{P.A.}{D.A.}$ 4
$T.S.$ 8,520
$1 - S$ ..... .875
V 20.91
$I.T._D$ 6
$I.H.P.$ ..... 4,879 (2 propellers)
$P.C.$ ..... .62
$E.H.P.$ 3,025
$S.H.P.$ 4,489

SURFACE PERFORMANCE

$\frac{e.h.p.}{E.H.P.}$	e. h. p.	v	$\frac{v}{V}$	Zp	K	S.H.P.d	Act S.H.P.d	Zs, curve 1, Fig. 7	S	s	Revs. Est.	Revs. Actual
.05	152	8.44	.404	—1.355	1	198		+1.043	.125	.0609	145.7	145
.075	228	9.57	.458	—1.1715	1	302		+.89	.125	.0654	166	166
.10	304	10.5	.502	—1.0414	1	408		+.77	.125	.0669	182.5	182.5
.15	456	11.86	.567	— .858	1	623		+.62	.125	.0723	207.3	207.5
.20	608	13.05	.624	— .7279	1	840		+.497	.125	.0735	228.4	228
.30	912	14.87	.711	— .5445	1	1281		+.335	.125	.0772	261.3	258.5
.40	1216	16.14	.772	— .4144	1	1729		+.233	.125	.0823	285.2	281.5
.50	1520	17.3	.827	— .3135	1	2181		+.154	.125	.0866	307.1	303.2
.60	1824	18.5	.885	— .231	1	2637		+.070	.125	.0863	328.3	328
.70	2128	19.36	.926	— .1613	1	3096		+.019	.125	.0901	345	347
.80	2432	20	.957	— .1009	1	3558		+.0	.125	.0991	359.9	363
.90	2736	20.5	.980	— .0477	1	4022		+.0	.125	.112	374.3	375

SUBMERGED CONDITION

e. h. p. / E.H.P.	e. h. p.	v	$\frac{v}{V}$	Z_p	K	S.H.P.$_d$	Act. S.H.P.$_d$	Z_s, curve 2, Fig. 7	S	s	Revs. Est.	Revs. Actual
.025	76	5.05	.242	—1.667	1	96.7	105	+1.84	.125	.1862	100.6	102
.05	152	6.44	.308	—1.355	1	198.2	109	+1.575	.125	.2075	131.8	129
.075	228	7.33	.351	—1.1715	1	302.5	280	+1.4	.125	.2116	150.7	146
.10	304	8.06	.386	—1.0414	1	408	364	+1.275	.125	.2141	166.3	161
.15	456	9.26	.443	— .858	1	622.5	550	+1.09	.125	.2133	190.8	184
.20	608	10.26	.491	— .7279	1	840	750	+ .95	.125	.2085	210.2	203
.30	912	11.85	.567	— .5445	1	1281	1170	+ .76	.125	.2053	241.8	235.5
.40	1216	13.15	.629	— .4144	1	1729	1620	+ .622	.125	.2016	267.1	262

Unfortunately in the case of this vessel no measure of shaft horsepower on the surface was taken, the vessel being driven by Diesel engines. In the submerged condition electric motors were the propelling units. Attention is called to the extremely close agreement between estimated and actual revolutions, the slips not, as yet, having changed their character from those of the first to those of the second order. In the submerged condition the actual powers were obtained by measurements of electric input and voltage to the motors and the resulting kilowatts transformed to shaft horsepower by dividing by the factor .746. The estimated $S.H.P._d$ is seen to be somewhat in excess of the actual, and this excess estimate is accompanied by an excess in estimated revolutions over the actual. Should the actual measured power at the highest submerged speed be used in the calculation of revolutions for that speed the resulting estimated revolutions become 264.1 instead of 267.1.

The vessel just discussed has an after body of such form that it is almost at the dividing line between vessels of type 2 and type 1 and the character and quality of the wake are so good that there is no augment of power; that is, $K = 1$.

Should the vessel be one of type 2, slips of the first order, but with the character and quality of the wake such that K is in excess of unity, the performance becomes radically different. Upon entering cavitation the value of K becomes increased to approximately $K_c = 1.26\ K$.

Suppose in the case of such a vessel a series of performances be taken in which the net load fraction $\frac{e.h.p.}{E.H.P.}$ is constant but the speed fraction $\frac{v}{V}$ for this load fraction is decreasing due to progressive loading of the vessel, then

$$\log I.H.P._d = \log I.H.P. + \log K - Z_p.$$

Now let

$$Z_{pg} = Z_p - \log K,$$

that is, Z_{pg} is the gross load factor for the propeller when delivering the net load fraction $\frac{e.h.p.}{E.H.P.}$ with a power augment K. Call the gross load fraction $\frac{e.h.p._g}{E.H.P.}$.

When $\frac{v}{V}$ has decreased until it reaches the intersection of the ordinate at $\frac{e.h.p._g}{E.H.P.}$ with the cavitating curve of the basic slip S, of the first order, cavitation ensues and K changes value to $K_c = 1.26\ K$.

The equation for power then becomes

$$\log I.H.P._d = \log I.H.P. + \log K_c - Z_p.$$

As the value of $\frac{v}{V}$ still decreases, calling the value of the load factor corresponding to the point on the cavitation curve of S whose ordinate is $\frac{v}{V}$, Z_1, the equation for power becomes

$$\log I.H.P._d = \log I.H.P. + \log K_c - Z_p + Z_1 - Z_{pg},$$

but $Z_p - \log K_c = Z_{pg}$; therefore

$$\log I.H.P._d = \log I.H.P. - 2Z_{pg} + Z_1.$$

As in Problem A, the slip before cavitation equals $s = S\frac{I.H.P._d\ 10^{z_s}}{I.H.P.}$, where Z_s is taken from Curve 1, Fig. 7, but as soon as the cavitation curve of S is passed, while the equation remains the same, the value of Z_s must be taken from Curve 2, Fig. 7.

Turning now to the second vessel, which is of the Lake type, the range of apparent slips of the second order is entered. In the estimates of revolutions both in and out of cavitation the values of Z_s are taken from curve 1, Fig. 7, but in the estimates of power in the cavitation range a corrective factor must be introduced. Let this factor be called K_1. Its values are found as follows:

Turning to Fig. 8, attention is called to two points marked Z_p, one plotted on $\frac{e.h.p.}{E.H.P.} = .575$ and $\frac{v}{V} = .78$, while the other is on $\frac{e.h.p.}{E.H.P.} = .5$ and $\frac{v}{V} = .51$. Now for either of these points to find the value of K_1 take the value of $\frac{e.h.p.}{E.H.P.}$, called $\frac{e.h.p._1}{E.H.P.}$, where this same value of $\frac{v}{V}$ cuts the cavitating thrust curve for the basic slip S of the vessel. The Z_p value for this value of $\frac{e.h.p._1}{E.H.P.}$ call Z_1, then $K_1 = Z_1 - Z_p$ and

$$\log I.H.P._d = \log I.H.P. + \log K - 2Z_p + Z_1$$
$$\log S.H.P._d = \log S.H.P. + \log K - 2Z_p + Z_1$$

and by transposing the equation

$$Z_1 = \log S.H.P._d + 2Z_p - \log S.H.P. - \log K$$

is obtained, from which, when the actual power and load fraction are known, the cavitation loss can be closely approximated.

Also, by transposing, the equation

$$2Z_p = \log S.H.P. + \log K + Z_1 - \log S.H.P._d,$$

from which the load fraction $\frac{e.h.p.}{E.H.P.}$ corresponding to Z_p can be ascertained.

VESSEL D

Hull		Propeller	
$L.L.W.L.$	= 203.75′	Blades	3
B	= 19′	Shafts	2
H	= 16.1′	Form	Standard
H_1	= 15.1	D	6.17′
$\frac{B}{L.L.W.L.}$	= .093	P	5.542′
$\frac{H}{B}$	= .847	$\frac{P.A.}{D.A.}$	.4
$L.A.B.$	= ½ $L.L.W.L.$	$T.S.$	8,530
$2L.A.B. \div H_1$	= 13.5	$1 - S$	.79
Nom. $B.C.$	= .481	V	18.65
$B.C.$ on $C - D$	= .35	$I.T._D$	6
$B.C.$ on $C - D$ cor. for $\frac{H}{B}$	= .52	$I.H.P.$	3,830
$S.B.C.$ on X	= .55	$P.C.$	.62
S	= .225	$E.H.P.$	2,371
		$S.H.P.$	3,523

VESSEL E

Hull		Propeller	
$L.L.W.L.$	= 168′	Propellers	1
B	= 36′	Blades	4
H	= 11.46′	Form	Standard
$B \div L.L.W.L.$	= .214	D	9.5′
$H \div B$	= .318	P	11′
$L.A.B.$	= ½ $L.L.W.L.$	Total $\frac{P.A.}{D.A.}$	.338
$2L.A.B.$	= 14.66	$P.A. \div D.A.$	.2535
Nom. $B.C.$	= .482	$T.S.$	6,010
$K.B.C.$	= .65	$1 - S$	.865
$B.C.$ on $A - B$	= .517	V	18.91
$B.C.$ on $A - B$ cor. for $\frac{H}{B}$	= .517	$I.T._D$	2.8
$S.B.C.$ on W	= .646	$I.H.P.$	2,218
S	= .135	$P.C.$	.659
		$E.H.P.$	14.62

ANALYSIS

$v = 13.17$ $\quad e.h.p. = 696$ $\quad Z_p = .35$ $\quad I.H.P._d = 1,228$

$\frac{v}{V} = .6965$ $\quad \frac{e.h.p.}{E.H.P.} = .4763$ $\quad K = 1.25$ $\quad$ Act. $I.H.P._d = 1,208$

$Z_s = .365$

$s = .1727$

$R_d = 146.5$

Act. $R_d = 146.7$

This vessel also was not used in obtaining any of the design curves.

SURFACE CONDITION—ANALYSIS

v	e. h. p.	e. h. p. / E. H. P.	Z_p	K	S. H. P.$_d$ Est.	S. H. P.$_d$ Act.	$\frac{v}{V}$	Z_s	S	s	Revs. Est.	Revs. Act.
6	60	.0253	1.667	1.06	80.4	80	.3217	1.32	.225	.1073	122.9	.....
8	144	.05075	1.32	1.042	176	200	.4289	.975	.225	.1061	163.6	160.1
10	268	.1131	.98	1.0	369	370	.5361	.688	.225	.1149	206.6	203.4
12	444	.1873	.757	1.037	639	632	.6433	.46	.225	.1177	248.7	247
14	740	.3122	.522	1.068	1131	1134	.7506	.2784	.225	.1371	296.7	300.5
16	1050	.443	.362	1.10	1684	1670	.8578	.11	.225	.1386	339.6	345
17	1360	.574	.25	1.13	2239	2500	.9114	.035	.225	.155	367.9	362.5

The power data for the 17 knot point are doubtful, as there was no way of measuring it and the shop brake test power for the revolutions was used.

To illustrate the method to be followed in making an estimate of the effective horsepower delivered by a propeller when the $I.H.P._d$ or $S.H.P._d$ and the speed of the vessel are known,

SUBMERGED CONDITION

v	e. h. p.	e. h. p. / E. H. P.	Z_p	$\frac{v}{V}$	e. h. p.$_1$ / E. H. P.	Z_1	K	S. H. P.$_d$ Est.	S. H. P.$_d$ Act.	Z_s	S	s	Revs. Est.	Revs. Act.
5	100	.04219	1.41	.2681	.05	.....	1.1	151	.....	1.55	.225	.3422	139	.....
6	140	.05512	1.31	.3217	.067	.....	1.08	186	.....	1.32	.225	.2482	145.9	.....
8	264	.1114	.983	.4289	.089	1.08	1.032	473	464	.975	.225	.2852	204.6	203.4
10	474	.20	.7279	.5361	.145	.87	1.00	914	896	.688	.225	.2846	255.6	253
12	774	.3265	.51	.6433	.255	.62	1.10	1543	1628	.46	.225	.2842	306.5	303.5

Neither of vessels A and B was employed in obtaining the curves of design, but, unfortunately, due to lack of reliable data, they both formed one of several vessels used in obtaining the values of K for their respective types.

Still another vessel, but this time of type 3, will be given as an illustration for that type.

the case of a vessel of a different type will be taken up in the next issue. In this case the hull will be of the Dreadnought type having a standard basic slip of approximately 13 percent. The vessel will be propelled by four 3-bladed propellers of standard form.

(To be continued.)

The Lubrication Problem on Shipboard

Oiling System Recommended by the Westinghouse Electric & Manufacturing Company for Geared Turbine Equipment

BY P. M. ROBINSON*

THE increasing use of high speed machinery for the development and transmission of power has brought with it the important problem of supplying adequate lubrication to the bearings and other moving parts in contact. In slow speed bearings (that is, under 50 feet per second rubbing velocity), the principal function of the oil is to interpose a film between the two rubbing surfaces to prevent metal to metal contact. However, in high speed bearings the amount of heat generated is more than can be dissipated by natural radiation; so that the oil must assume the additional function of carrying away the heat. To accomplish this purpose a considerable quantity of oil must be supplied; a quantity far in excess of the few drops per minute that are sufficient to keep a slow speed bearing operating satisfactorily. Therefore, to supply fresh oil continually would be out of the question. Instead the oil is drained away and saved to be used over again after having been restored to its original condition of temperature and purity. Thus there arises the necessity for a system to circulate and condition the lubricating medium.

The last few years have seen hundreds of vessels equipped with geared turbine-propelling machinery, a large proportion of which represent war orders placed by the United States Shipping Board Emergency Fleet Corporation. The oiling systems employed varied widely in character and makeup, depending largely upon the individual ideas of the shipbuilder or engine builder. Very often these systems proved inadequate, due somewhat to the severe operating conditions resulting from the war emergency and the inexperience of the operating engineers with the geared-turbine type of machinery; but also due to a large extent to the improper design of the oiling system itself.

Just at a time during the war when the greatest possible ship tonnage was needed, the Emergency Fleet Corporation was faced with the situation of having numerous vessels laid up with machinery trouble which, when analyzed, proved to be due very largely, either directly or indirectly, to faulty lubrication. Therefore a very thorough investigation was inaugurated by the Technical Division of the Corporation, which developed some very important information.

It was found that the systems in use were of two general types which could be designated as *gravity* systems and *pressure* systems. In a gravity system the oil is pumped from the drain tank into an overhead tank from which it is fed to the bearings by gravity, the tank being high enough to maintain the proper oil pressure. In a pressure system the oil is pumped from the drain tank and fed directly to the bearings under pressure from the pump.

Inherently the gravity system is the more reliable of the two, due to the fact that if the oil pump stops there will still be a few minutes' supply of oil in the gravity tank to keep the bearings lubricated until the spare pump can be started or the main machinery shut down. It was, therefore, logical for the Fleet Corporation to standardize on a gravity system and it is now considered the only system suitable for merchant vessels.

Some engineers are inclined to disagree with this conclusion and point to the navy, where pressure systems are the rule. However, on a naval vessel there are very good reasons for using a pressure system. On destroyers and light cruisers there is not head room enough available for installing a gravity tank, and on the larger ships it would mean placing the tank above the protective deck, which would be undesirable. However, on the other hand, naval vessels are operated full power only a small percentage of the time and the engine-room crews are much larger than in the case of merchant craft, which features offset the difference in latent reliability.

The Emergency Fleet Corporation developed a standardized oiling system which has proved very successful (see MARINE ENGINEERING, June, 1920, page 508). However, it is believed by the engineers of the Westinghouse Electric & Manufacturing Company that a few changes could be incorporated with advantage, and on all new equipments for privately owned vessels the Westinghouse Company is recommending a system as shown in Fig. 1.

WESTINGHOUSE OILING SYSTEM

The general layout of this recommended system indicates that there are included the following essential elements:

Gravity tank,
Drain tank,
Oil pump and duplicate auxiliary pump,
Oil cooler and duplicate auxiliary cooler,
Oil strainer,
Settling tank,
Oil purifier,
Reserve tanks.

The oil is fed by gravity from the gravity tank to the various bearings and gear sprays on the main propelling unit, from which it is drained into the sump or drain tank. From here the oil is pumped back to the gravity tank, passing on its way through the oil cooler and the strainer.

The arrangement is such that either pump may be used while the other is held as a standby. The speed of the pump is regulated by a float control device, located in the gravity tank, which maintains a constant level in the tank. The connection between the float and the pump may either be mechanical or the steampipe may be led up to the gravity tank so that the throttle can be immediately adjacent to the float. However, the mechanical connection is to be preferred, if a direct lead can be obtained. The level of the oil in the tank may be maintained high enough so that a slight excess is constantly running out through the overflow pipe leading back to the drain tank.

The oil coolers are so connected that either one may be used separately or both may be used together in parallel. Should both coolers be out of commission at once, a connection is available for by-passing them entirely. The valve in the by-pass line is of the spring loaded type, which may be held open by the hand wheel, or should an obstruction occur in the cooler, it would open against the spring, thus insuring a flow of oil at all times.

From the lowest point in the strainer box, gravity tank and reserve tanks there are pipes which lead to the settling tank, located just below. These pipes do not connect directly into the settling tank but are arranged to drain into a strainer funnel on the top of that tank, and they are so pivoted that either pipe may be swung out to discharge into a bucket or other receptacle for sampling purposes. It is recommended that enough oil be drained from the strainer box and gravity tank each day to prevent any accumulation of water or dirt. As soon as the clean oil begins to flow from the pipe it will be evident that enough has been drained. Steam coils are

* Marine Engineering Department, South Philadelphia Works, Westinghouse Electric & Manufacturing Company.

provided in the settling tank to hasten the settling process and to condition the oil for purification.

Just below the settling tank is located the purifier, which may be either of the centrifugal type or a filter. It should be operated each day long enough to take care of the dirty oil which has been drained into the settling tank. The purified oil is led back to the drain tank. At the end of each voyage all the oil in the system should be passed through the purifier.

Provision is made for filling from the deck either into the reserve tank or into the gravity tank. The filling pipe should be pivoted so that it can be swung out of the way when not in use. This precaution is made necessary by the possibility of water leaking through the deck-filling hole. As a further precaution against foreign matter the arrangement is such that no fresh oil can get into the bearings without first passing through the strainer. If the fresh oil is led into the reserve tank, it can only get into the system by passing down into the drain tank, from whence it would have to pass through the strainer on its way to the gravity tank. If the fresh oil is led into the gravity tank, the connection is such that it must pass through the strainer on its way.

A description of the various units for a 3,000 shaft horsepower installation is given below. For a larger job the units would be increased proportionately.

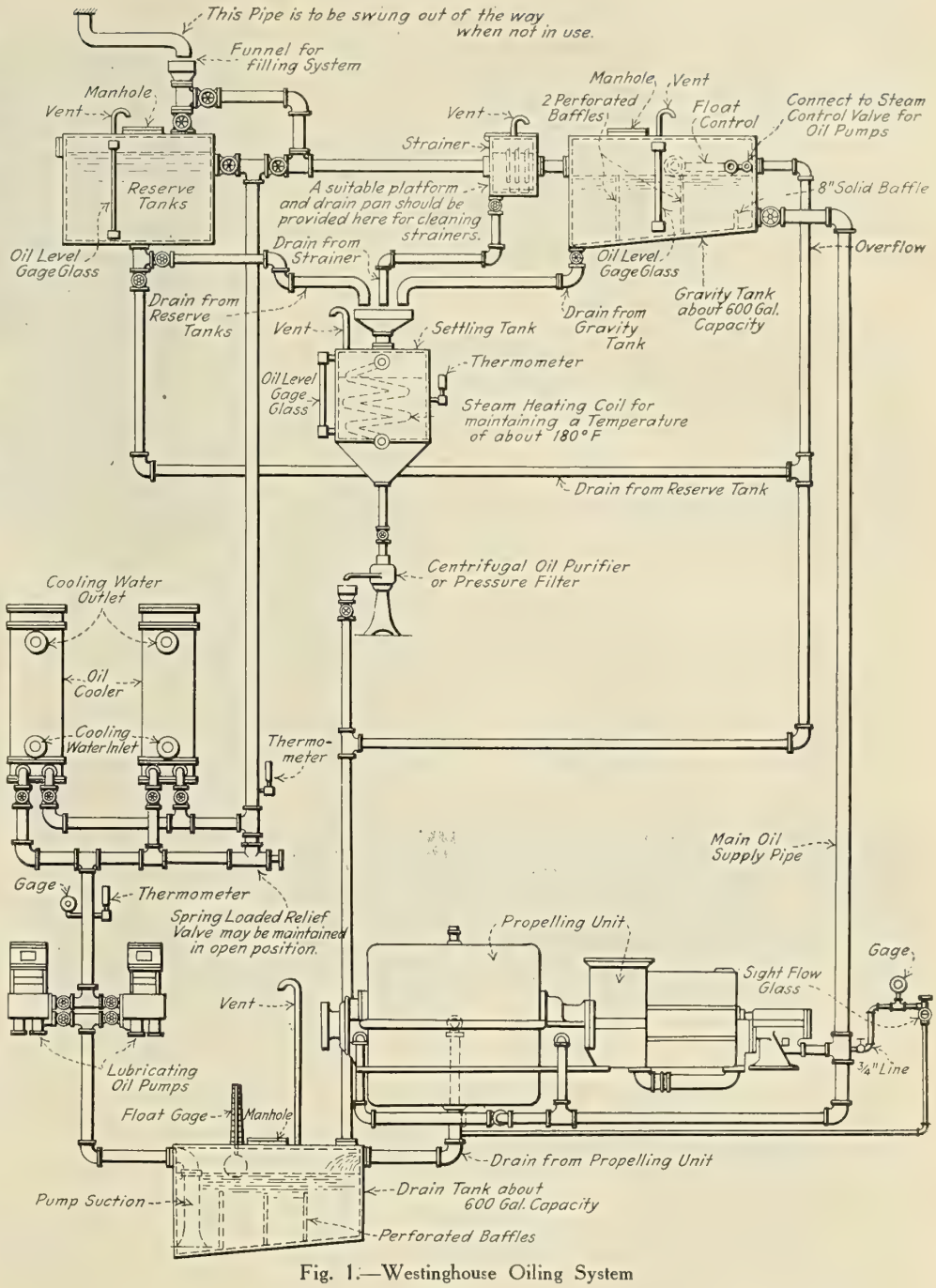


Fig. 1.—Westinghouse Oiling System

Gravity Tank

The gravity tank should be placed in the engine room hatch at a height that the distance from the centerline of the turbine to the bottom of the tank is not less than 20 feet nor more than 30 feet. The tank is rectangular in shape with a capacity of about 600 gallons up to the overflow pipe. Toward one end the bottom slopes gradually to a drain leading to the settling tank. The tank should be placed so that the bottom slope is fore and aft, and not athwartship.

The inlet connection to the tank is located slightly above the normal oil level so that any foam can be liberated on the surface.

The main supply pipe is led from the side or bottom of the tank at the shallow end, where a solid baffle plate extends across the tank to prevent any accumulation of dirt at the bottom of the tank from being carried over into the supply line.

A sufficient number of perforated baffle plates are installed to prevent excessive splashing of the oil due to the rolling of the ship.

The overflow pipe is led from the side of the tank several inches from the top so that the tank will never be absolutely full. It is desirable always to have a surface for the dissipation of foam.

A float control device of rugged character is included to regulate the speed of the oil pump and is connected thereto either by mechanical means or the steam pipe may be carried up to bring the throttle valve adjacent to the float. The former is to be preferred where a direct lead can be obtained.

The gravity also includes such accessories as a gage glass, a vent pipe and a manhole to allow cleaning.

Drain Tank

The drain tank should always be separate from the ship's structure to avoid any leakage of salt water into oil. It should have a capacity of about 600 gallons and should be located entirely below the level of the bottom of the gear case, so that there will always be a free drain from the gears. This is very essential so that any foam that may be churned up in the gear case can be carried away. For the same reason it is imperative that the drain pipe should enter the tank at or near the top so that the opening is never submerged.

The bottom of the tank should slope slightly in a fore and aft direction and the suction line should be located at the lowest point. This is fitted with a bell mouth close enough

to the bottom to prevent any accumulation of sediment or water. Since there is no provision made for getting rid of any such sediment in the drain tank, it is the best policy to allow none to collect. Ample provision is made above for cleaning the oil before it reaches the bearings.

Perforated baffle plates similar to those provided in the gravity tank should be included in the drain tank to prevent excessive splashing. There should also be fitted a vent pipe extending at least to the height of the centerline of the gear case, a float gage and a manhole for cleaning.

Oil Pump

Two independent oil pumps are provided, each of which is of sufficient capacity alone to supply the entire quantity of oil used when running at a moderate speed, say 40 to 50 double strokes per minute. They are of the duplex type and should be located at as low a point as possible to reduce the suction head.

These pumps must of necessity be of the most rugged construction to secure the maximum reliability. Bronze valves and metallic packing should be used throughout since fibre packing has a tendency to disintegrate and get into the oiling system.

Oil Cooler

Two coolers are provided, each of which is of sufficient size to cause a temperature drop of at least 20 degrees F., when oil is circulated at the rate of about 175 gallons per minute and cooling water at 70 degrees F. is circulated at the same rate. The oil may either pass around the tubes or

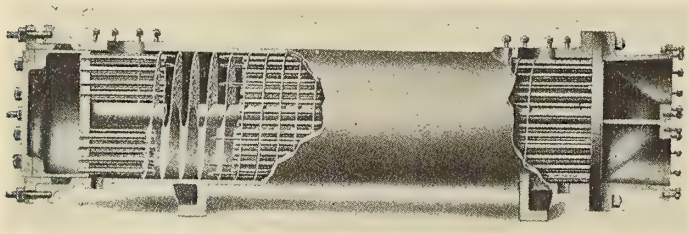


Fig. 2.—Typical Oil Cooler

through the tubes, according to the type of cooler used, but in general it should be so designed that the pressure drop on the oil is greater than the pressure drop on the water. In this way the pressure needed on the water side is less than that needed on the oil side, and care should be used to see that this condition is always maintained so that any leak will be from oil to water and not water to oil. To test for an oil leak a drain connection is provided on the cooling water discharge line, from which a sample can be drained at any time for examination. A typical cooler is illustrated in Fig. 2.

Circulating water is supplied by an independent pump with an auxiliary connection to the main circulating unit.

Oil Strainer

There are two types of strainers, the duplex pressure strainer and the gravity strainer with flat vertical screens.

When a duplex strainer is used it should be placed on the discharge side of the pumps and never in the suction line. It is so arranged that one basket may be cleaned while the other is in operation, and when it becomes clogged the valves are shifted so that the oil passes through the clean basket.

The duplex strainer is inherently a dangerous element in the system. When the basket in operation becomes clogged, if the valves are not changed over immediately, either the flow of oil will be stopped or the basket will burst, allowing the accumulation of dirt, together with parts of the broken basket, to pass on into the system. To prevent this occurrence it is imperative that a by-pass be provided in which there is

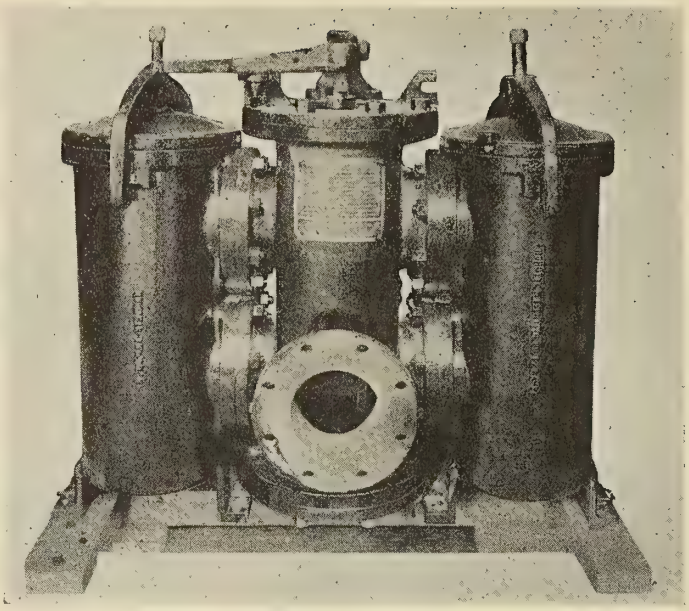


Fig. 3.—Duplex Pressure Strainer

a spring loaded-check valve, loaded to, say, five pounds, so that as soon as the strainer becomes choked the increase in pressure will permit the oil to by-pass and no interruption in the flow of oil will be experienced. An indicator showing the flow through this by-pass could be easily fitted to warn the operator that the strainer needed cleaning.

Fig. 3 shows the general appearance of this type of strainer.

The gravity type of strainer automatically eliminates the possibility of stoppage of oil by its construction, and since the oil flows through the screens by gravity alone it must necessarily be placed at the top of the system on a level with the gravity tank. Fig. 4 shows the construction of this type of strainer.

It consists of a rectangular box in which are placed three screens, through which the oil passes in succession. The first screen is sheet metal perforated with 1/16-inch holes. The second screen is wire gauze of 35 mesh to the inch. The third screen is wire gauze with a mesh of 70 to the inch. The screens fit tightly in the bottom and sides of the tank but do

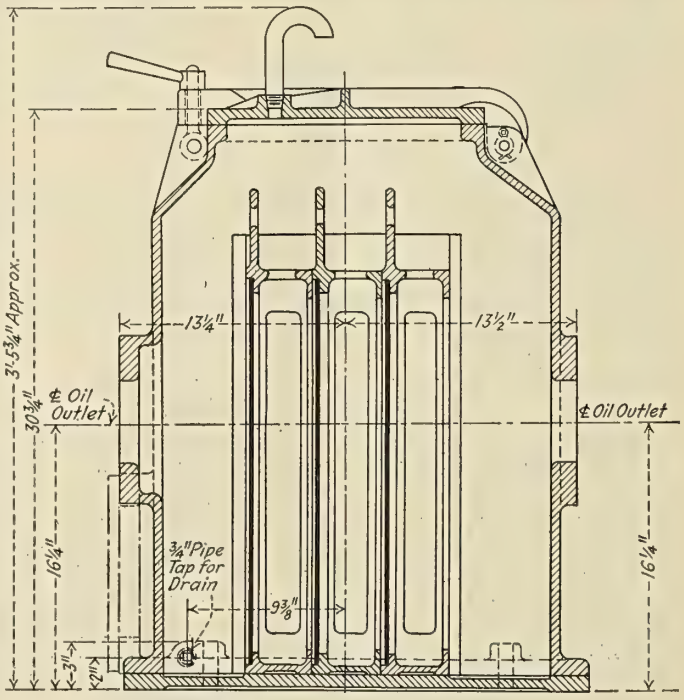


Fig. 4.—Section of Gravity Strainer

not reach to the top. The oil is not forced through the screens by any pressure from the pump but merely by a difference of the oil level on the two sides of the screens. As the screens become clogged this difference becomes greater until the oil finally flows over the top. When this condition is reached the screens should be cleaned, but the fact that they are not attended to immediately does not stop the flow of oil.

The screens can be readily cleaned without interrupting the operation of the system. By opening the cover of the strainer box each screen may be lifted out separately and thoroughly cleaned. At the bottom of each screen frame is provided a lip, which catches any dirt which may fall from the screen while it is being removed, thus preventing any of the accumulated dirt from returning to the system.

For cleaning the screens properly a suitable platform should be provided near the strainer box, where steam or air hose may be made available for easily doing the work. It will be found in a new installation, or in an installation where the machinery has been opened for inspection, that a considerable amount of dirt will be collected on the screens and it will be necessary for some hours at least after the oiling system is placed in operation that they be cleaned almost continuously. After this perhaps the cleaning can be reduced to once a watch or even once a day. Too much stress cannot be laid on the necessity of these being maintained clean, and it is on account of the lack of this precaution that some difficulties have been encountered.

From the bottom of the strainer box there is an open drain leading to the settling tank, which should be opened for a few minutes each watch to carry away any collected sediment or water.

Settling Tank

The settling tank is cylindrical in shape with conical bottom, having a capacity of about 600 gallons, and is provided with heating coils for preparing the oil for purification.

The drains from the strainer box, gravity tank and reserve tanks lead into an open strainer funnel on top of the settling tank and at the very bottom a discharge pipe leads to the oil purifier. There is also included a gage glass, a thermometer, a vent pipe and a manhole for cleaning.

Oil Purifier

For purifying the oil and getting rid of the water and foreign matter, there are two devices available. One is a centrifugal machine and the other is a filter, the first of which is probably to be preferred. A unit of not less than 100 gallons per hour capacity should be installed. The best results will be obtained by heating the oil to about 180 degrees F. before passing it into the purifier.

Fig. 5 shows the arrangement of a centrifugal purifier, while Fig. 6 illustrates the construction of a filter.

Reserve Tank

Reserve tanks of sufficient capacity should be provided to carry at least one full charge of fresh oil.

Oil Piping

Pipe sizes should be determined on the basis of about 175 gallons of oil flowing per minute at the following velocities:

Oil in drain return pipe from bearings and gear, not to exceed 80 feet per minute.

Oil in suction line, not to exceed 125 feet per minute.

Oil in supply lines and pump discharge not to exceed 250 feet per minute.

Connecting branches should be at least as large as the connections furnished on turbines and gears.

All piping should be fitted with flange joints and unions, so as to allow complete disassembling for cleaning without unscrewing any joints.

Thermometers are fitted in the inlet and discharge lines of the cooler. On the main supply line on a level with the turbine centerline is fitted a pressure gage and a flow indicator. And a pressure gage is fitted on the discharge line from the oil pump.

Quality of Oil

The oil should be a pure mineral oil, for if animal or vegetable oils be employed, they will saponify should any salt water come in contact with them, and there is furthermore the danger that they will turn acid with long use. The oil is at all times at a temperature of from 120 to 150 degrees F., which is in itself conducive to any chemical reaction should the necessary elements be present.

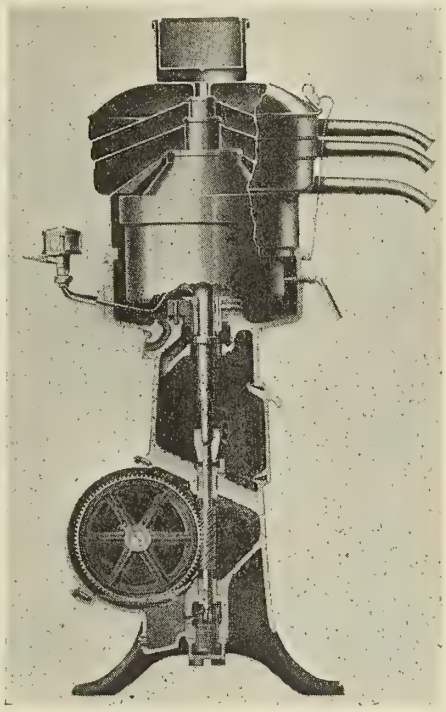


Fig. 5.—Centrifugal Purifier

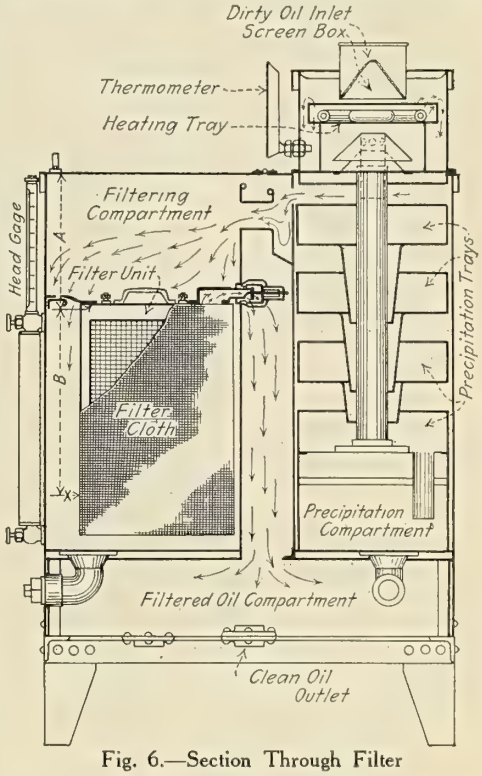


Fig. 6.—Section Through Filter

The choice of oil, so far as viscosity is concerned, is important. In the case of direct-connected installations, where no gears are employed, and, for instance, land installations where the turbines are directly connected to generators, a viscosity of 150 to 200 seconds Saybolt at 100 degrees is to be preferred, this low viscosity being chosen because, generally, lower viscosity oils are less subject to emulsification than those of higher viscosity. Furthermore, the journals are all of high speed and the bearing losses are smaller with the lower viscosity oil. Such an oil as this, however, is not suitable where gear teeth are to be lubricated, and for this purpose an oil of about 300 seconds Saybolt at 100 degrees is required, and in cases where the pinion or turbine bearing velocities do not exceed 70 feet per second, an oil as high as 500 seconds may be employed. The only effect of the higher viscosity oil on the turbine bearings will be that they will operate at a slightly higher temperature than if lower viscosity oils were employed, which need cause no concern whatever.

Any oil should have the paraffine, asphalt, or any other matter which may soldify, thoroughly expressed therefrom, as the matter may become separated from the oil, choking up the oil passages.

Oil should be selected, which, having the required viscosity, will have the least tendency to emulsify in the event of the accidental admixture of salt water.

Blended oils are to be avoided, for one kind of oil is more subject to emulsification than another; usually the one of higher viscosity being more liable to emulsification; so that with a blended oil, should any water become mixed with it, the heavier oil may go into emulsion, leaving the lighter oil behind, which perhaps may be of little value as a lubricant.

All bearing pedestals, reservoirs, etc., and all places where oil may collect, should be examined from time to time, to be sure that there is no accumulation of any solid matter. The piping comprising the system should be installed in such a way that it may be readily disassembled without unscrewing joints, as it is necessary that these be occasionally taken down and cleaned, the frequency of which operation, however, depends largely on the care of the oil in the manner outlined above.

Presumably at some period the charge of oil should be entirely replaced. No statement, however, can be made as to the length of this period. With the care outlined herein, it is believed that the life of the oil will be, as is experienced in land power stations, well nigh indefinite. Samples of the oil should, however, be taken from the system from time to time when in operation, and subjected to examination to determine that it has not deteriorated, plainly, and a new charge of oil should be subject to the same careful scrutiny as in the first instance.

Given a good lubricating oil system it is up to the operating engineer to see that it is properly handled, and under such conditions the geared turbine as a propelling unit has proven itself admirably reliable.

The Anshutz Self-Steering Compass

THE Anschütz gyro-compass, manufactured by Anschütz & Company, Neumühlen b. Kiel, Germany, has promoted the art of navigation enormously by virtue of two main features distinguishing it from the magnetic compass:

1. By its independence of all exterior magnetic or electric influence.
2. By the complete absence of lag or, in other words, by its steadiness in pointing true North.

The first advantage has made the *calculation* of the true course much easier and completely reliable. The second advantage gives an otherwise unattainable accuracy in *keeping a straight course.* The inner dial of the repeater-card allows one to read off the course with an exactness figured in tenths of degrees. The most insignificant yaw of the ship is at once stated by a movement of this inner dial, and that even more easily than if steering by land-marks. By aid of the Anschütz gyro-compass it is possible to steer even an unhandy ship, after a short experience, with an exactness of about 1.5 degrees.

Such an essential improvement of course-steering has suggested the idea of depending entirely upon the repeater to keep the ship on the actual course. The repeater is set in action by a comparatively great force. After a long line of experiments and practical experience, last of all on small, fast steaming boats, the steering of which was a very difficult task, the self-steering compass was developed, i.e., the Anschütz gyro-compass in mechanical connection with the steering-wheel of the telemotor of the rudder-engine.

The work of the helmsman, observing the compass-card and striving to neutralize every yaw by a corresponding turn of the steering wheel, is now done by an electro-motor controlled by the gyro-compass repeater motor. Like a good helmsman the self-steering compass causes a small turn of the wheel at a small yaw of the ship; the greater the yaw, the greater the turning of the wheel. Since the yaw is immediately followed by the turning of the wheel, without any loss of time, the rudder-engine is worked very little and the ship is nevertheless kept on a virtually straight course. In still water the steerage way seems to be drawn with a ruler. It is a matter of course, that with such a straight course a voyage can be made in a much shorter time with a corresponding saving of fuel. Not only are time and fuel saved but also the wages, food and subsistence of the helmsmen, whose mechanical and dull work is done by a most simple and reliable engine. The new little helmsman eliminates mistakes, he is at work day and night without fatigue and last but not least—he never gets drunk; in short, he is the most trustworthy little helmsman imaginable.

Mechanical Construction

In Fig. 1 the steering wheel of the telemotor is marked 1 and the self-steering compass 2. Both are joined by the link-

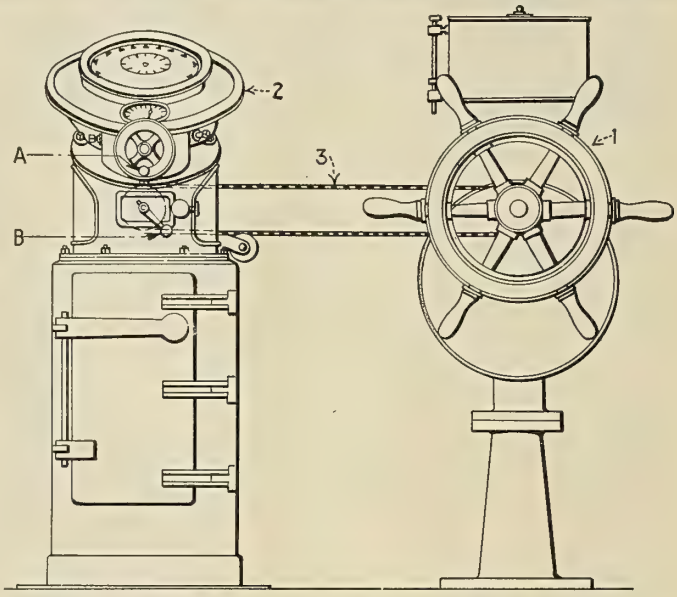


Fig. 1.—Self-Steering Compass and Steering Wheel of Telemotor

chain 3, running over a cog-wheel on the barrel of the steering-wheel. Both cog-wheels are always turning alike.

The compass card on the top of the apparatus is of the same type as in the usual Anschütz-repeater. The little dial underneath is the pointer of the helm recorder, recording the angle of the rudder. The hand wheel *A* serves to alter the course of the ship and the lever *B* is used for switching on or off the mechanical connection between self-steering compass and rudder engine.

Electrical Connection

The repeater of the self-steering compass is connected with the box containing the reversible motor of the Anschütz gyro-compass in the same way as are the other repeaters. By a little contact at the card an electro-motor is put into action starting the rudder engine at the smallest amount of yaw.

The motor contained in the lower part of the binnacle of the self-steering compass is energized by a suitable direct current circuit of the ship. The maximum load of this motor amounts to about 500 watts.

The brightness of the lamps illuminating the compass card from below can be regulated in three degrees by a step-switch.

Management

The handling of the self-steering compass is understood at a glance. Before starting it the indication of the card is checked by the master compass. The motor in the lower part of the binnacle is started turning over the lever *B* from "hand-steering" to "self-steering." This is done, when the pointer

of the helm recorder points to "midship position." From this moment the ship is steered automatically on the actual course.

An alteration of course is executed by the hand wheel *A*. Suppose the ship be running on a course of 82 degrees. A renewed calculation shows that the ship should stand on 86 degrees. In such case the circular division of the hand wheel *A* is turned to zero and then the handle of the wheel is turned four divisions to the left. That corresponds with an alteration of course of 4 degrees. By this manipulation the ship is at once brought round to a course of 86 degrees. All way-

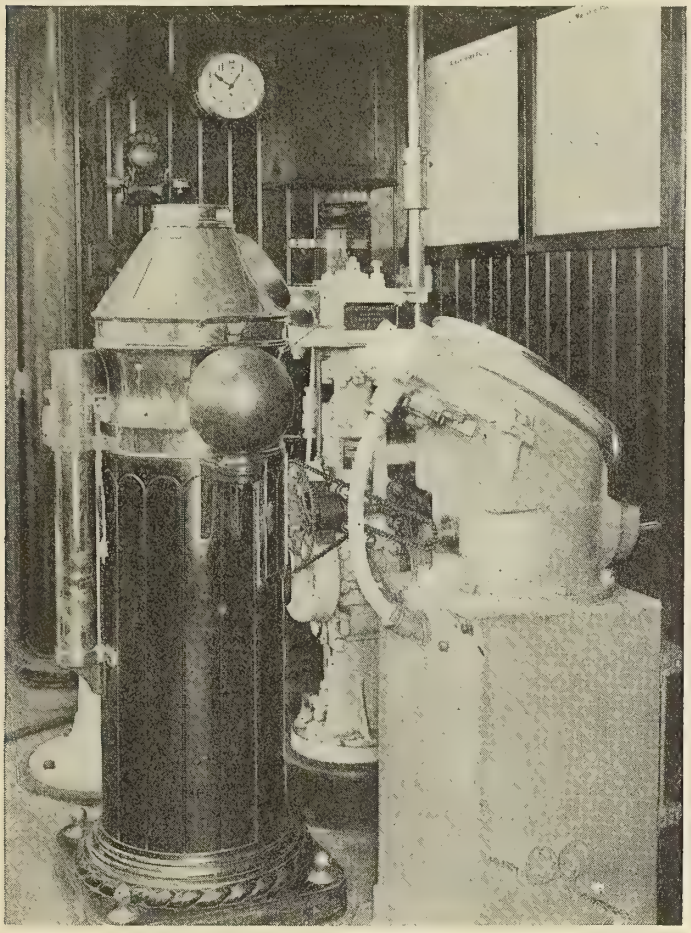


Fig. 2.—Chart House Installation

giving maneuvers are executed in the same simple manner by a turning of the hand wheel *A*. With the hand wheel loose, the ship will run straight on the actual course.

In case of emergency the steering wheel can be immediately employed. As soon as it is set free, the self-steering compass again takes the steering of the ship. At such intermediate application of the steering wheel one feels a somewhat increased resistance, which disappears when the lever *B* is turned from "self-steering" to "hand-steering." When hand-steering is desired, the lever is of course to be turned back to "self-steering."

The gyro-compass with its accessory instruments opens up unlimited possibilities of development. The Anschütz-course-recorder allows the coupling of the speed of the ship, recorded by a log of latest type, with the course, recorded by the gyro-compass. Thus the position of the ship is stated at every instant with the greatest exactness, without taking bearings and without calculations. The track-table of the course-recorder is registering and reproducing the path of the ship on a sea chart and permits the commander to control the execution of his commands. The admiral of a fleet is enabled to combine the maneuvers of all his ships on a true scale by aid of the registrations of the course-recorder of every ship. The course-recorder can be applied to many other purposes, but this shows sufficiently the increase of security and the savings of work and hands afforded by this new instrument.

Electricity Applied to Ship Auxiliaries*

BY H. L. HIBBARD†

IN all ship work reliability is of the first importance and electrical apparatus for ship auxiliaries must be ruggedly constructed, yet at the same time need not be clumsy. Furthermore, each piece of electrical apparatus should be particularly designed for the service and conditions to be met. These conditions need to be carefully *studied* and too great emphasis cannot be laid on this point, as it is at the root of the successful operation of electrical machinery.

Motors on deck will in many cases frequently be awash and hit by heavy seas, also, when the crew is washing down the deck, the hose will often play over the motors. Vessels trading in tropical climates will have deck machinery subject to the excessive heat of the tropical sun and all vessels on northern routes have their deck motors at times subjected to very low temperatures. In the engine room leaky steam pipes are a danger to the motors, and where Diesel engines are employed for the propelling machinery, thought should be given to the protection of motors and controllers from oil fumes and drippings.

Engine Room Auxiliaries

As an example of the engine room auxiliaries which are included in a large oil engine driven vessel, the following is a list of those supplied on one of our latest motorships, the *Cubore,* of 11,500 tons deadweight capacity:

Auxiliary	No.	H. P.	Location	Motors Type	Motors Open or en.	Control Type	Control Open or en.
Fresh Water Pump	1	5	Floor	Hor.	Encl. Vent.	Mag.	Encl.
Turning Gear	1	20	"	"	"	Mult. Switch	"
Booster Compressor	1	25	Platform	Ver.	Open	Mag.	"
Refrigerator	2	5	"	Hor.	"	Hand Start	"
Oil Transfer Pump	1	3	Floor	"	Encl. Vent.	Mag.	"
Steering Gear	1	25	Steer Room	"	Encl.	Spec.	"
Circulating Pump	2	25	Floor	Hor.	Encl. Vent	Mag.	Encl.
Lubricating Oil Pump	1	7½	"	"	"	"	"
200-Ton Ballast Pump	1	15	"	"	"	"	"
Bilge Pump	1	15	"	Ver.	"	"	"
Air Compressor	2	125	Platform	"	Open	"	Open
500 Ton Ballast Pump	1	50	Floor	Hor.	Encl. Vent	"	Encl.
Lub. Oil Purifier	2	1	For'd Blk.	"	Encl.	Hand Start	Open
Fuel Oil Pump	2	3½	Floor	Hor.	Encl.	Mag.	Encl.
Sanitary Pump	1	7½	"	Hor.	Encl. Vent	Mag.	Encl.
Lathe	1	1½	Platform	"	Open	Mag.	Encl.
Grinder	1	3	"	"	"	Hand Star.	Open
Drill	1	2	"	"	Open	"	"
Generator	2	100 k. w.	Floor	Oil engine driven			
Generator (Emergency Set)	1	100 k. w.	"	Geared steam turbine driven			

For a steam driven vessel many of the above auxiliaries will be similarly used in the engine room with the replacement of the several oil pumps and engine circulating water pumps by boiler feed, condenser, condensate pumps, etc.

The control for these engine room auxiliaries would be generally by the hand operated watertight panel or the push button watertight construction unless the centralized control were utilized.

* From a paper presented at a joint meeting of the New York Section of the American Institute of Electrical Engineers and the Metropolitan Section of the American Society of Mechanical Engineers, New York, January 28, 1921.

† Manager marine department, Cutler-Hammer Manufacturing Company, New York.

The auxiliary upon which probably more thought and study is being given at the present time from an electrical standpoint, than any other on shipboard, is the cargo deck winch. This is an especially important piece of machinery on a vessel handling miscellaneous cargo, and reliability of operation, and range of speed control in both hoisting and lowering, are of prime consideration.

Deck Machinery

Much discussion has been had of late with regard to the exact type of control to be furnished for deck winches and the results to be accomplished. One manufacturer is strongly advocating at the present time the electrically operated winch but provided with mechanical load lowering brake in place of the customary dynamic electric lowering control. While differences of opinion naturally exist on these details, one point is obvious; that the ideal electric winch is one which provides as nearly as practicable a straight horsepower curve, accommodating its speed automatically to the value of the load and permitting the handling of light and heavy loads without the necessity of changing gears; also that it gives in lowering as near as practicable, corresponding range of speeds for heavy and light loads down to the empty hook. And it must be borne in mind that time gained in the hoisting and lowering of the empty hook is that much clear gain in loading and unloading the vessel.

In the case of deck winch equipments and anchor windless as well, it is the practice to provide a mechanical brake on the motor shaft, electrically operated, to prevent falling of the load in case of failure of voltage.

Advantages of the Electric Drive

It has been shown by experience, that the electric drive of the auxiliary machinery has resulted in a considerable saving in fuel consumption of a vessel. And, also, the more efficient the propelling machinery, the greater the saving that may be obtained by the adoption of electric auxiliaries.

This is due to the fact that with steam driven auxiliaries, the exhust steam from the auxiliaries in the engine room is utilized principally for feed water heating. Where the total steam consumption, including propelling machinery, is heavy, a larger quantity of this exhaust steam can be efficiently utilized than where the total steam consumption is not as great. This applies only to such auxiliaries as are in constant use during the voyage. It is evident, therefore, that until the limit of feed water heating has been reached, the reduction in the steam consumption taken by the auxiliaries will not have nearly as great effect on the fuel consumption as would be the case after this critical point has been passed.

The above applies particularly to vessels using steam for their main propulsion. For ships operated by Diesel engines or Diesel electric drive, it is obviously of great advantage to operate all the engine room auxiliaries by electricity as it is largely a question of the efficiency of electric transmission with a large and reliable generating unit, against a number of small inefficient oil or steam engines, and it is naturally desired to avoid the generation of steam in any quantity on a motorship.

Aside from the engine room auxiliaries referred to above, attention is particularly drawn to the deck auxiliaries which are located some distance from the generating plant and where great losses would take place in the steam pipes feeding them. In these cases the electric drive is by far the most efficient method, irrespective of whether the vessel is steam or oil engine propelled. Some idea can be obtained of the loss of steam on the steam type of auxiliary when it is remembered that it is frequently considered essential to keep steam on the winch and windlass engines in cold weather to prevent the cylinders cracking or pipes bursting from freezing. The steam steering engine is a particularly noteworthy example of the wasteful use of steam as it is in effect only a steam ram taking steam full stroke with valves always left cracked a small amount.

The electric motor is always operating at a point of high efficiency and does not suffer in this respect from change of climatic conditions. Furthermore, the power transmitted through electric cables is practically a constant quantity regardless of temperature conditions, while steam transmission is affected very decidedly thereby.

The electric drive in addition to its convenience, adaptability and ease of operation, has the further merits of being available at any instant without preliminary warming up, or as above stated, the losses while standing idle with the steam plant.

Space, Weight and First Cost

Comparative figures which have been reliably obtained indicate generally some increase in the weight and space occupied for the electric over steam drive. In some cases however, such as the steering gear, an actual saving in space and weight is usually effected with the electric, and in other cases the difference is very slight. In the matter of first cost, it is also apparent from such figures as have been available to date, that electrical auxiliary machinery is roughly about 20 percent more expensive than steam, except in case of deck winches where the difference is more, sometimes 100 percent. It is also found that an oil engine propelled motorship is about 30 percent more expensive in first cost than a steam driven vessel and that, strange as it may seem, the Diesel electric propelled ship is slightly less expensive than the straight Diesel owing to the smaller and higher speed oil engines which it is possible to utilize.

As against these disadvantages of first cost and weight, are obtained the advantages of:

1. Suppression of heat in spaces adjacent to the gear and transmitting lines which is of importance in certain cases.
2. Elimination of accidents due to freezing and bursting of steam pipes, cylinders, etc.
3. The reduction of vibration and noise and an increase in the habitability of the ships due to these factors. This is particularly marked in the case of the steering gear.
4. The simplification and flexibility of control, operation being obtained readily from the most convenient point.
5. The obtaining of mechanisms as outlined above which are very much more efficient in operation than the steam equipments. This is the most important consideration.

Economy of Operation

That a very appreciable saving in the fuel consumption can be obtained by the use of electric drive is without question. According to an English writer, in modern equipment with propelling machinery consisting of double reduction geared turbines using superheated steam a saving of 8 to 10 percent of the fuel bill can undoubtedly be obtained by the adoption of electric drive on the auxiliary machinery.

Another important consideration is the fact that experience shows on motorships already constructed with electrical auxiliaries, that in port the power required during the period that the deck winches are handling the cargo is about three times the amount required with the auxiliaries at sea. Investigation of cargo handling vessels in general has shown, furthermore, that winches are idle five to eight times the amount of time they are in operation during an eight-hour day of work. With electric drive power is completely shut off while the winches are out of operation, but in the case of the steam equipments condensation and leakage continue the same.

While we have numerous general advices to the effect that the fuel consumption of steam driven auxiliaries is at least ten times that of electric, etc., we have some specific figures from oil engine driven vessels plying between Australian points and the Pacific Coast, which show a saving of approximately 25 percent in fuel consumption due to electric auxiliaries. Examination of the records of other ships shows a similar percentage gain.

The Fuel Problem for Steamships

BY LAWRENCE B. CHAPMAN

Although the burning of oil as fuel in marine installations has many advantages over coal, the rising cost and failing supply will undoubtedly limit its use within the next few years to naval and fast passenger vessels. The increased efficiency of coal firing by the possible adaptation of stokers to marine requirements, as well as the possible development of pulverized and colloidal fuels, may solve the problem in the future.

IN making a comparison between coal and fuel oil for use in steam generation on shipboard, the problem should be considered carefully from every angle, for there are many features connected with the use of fuel in oil burning vessels that have little or no influence in shore installations. Some of the points to consider are: Cost, weight, bunker space required, availability and future supply, adaptability.

Relative Costs of Fuels

In making a study of the costs of the two kinds of fuel, the comparison should be based on the amount of fuel necessary to produce equal amounts of steam under the same conditions of feed temperature and boiler pressure. In order to make this comparison, certain assumptions must be made regarding the heat content of the fuel and the boiler efficiency. The comparison will have to be of a general nature, for both these factors vary through a considerable range. Fair average figures for heat contents are 14,300 British thermal units per pound for coal and 18,800 British thermal units for fuel oil. The boiler efficiency when operating with coal has been assumed as 69 percent, and with fuel oil as 75 percent. These efficiencies are for operation under the best of conditions; trials will show higher values, but, generally speaking, efficiencies under working conditions will be lower. However, the figures given are comparable, regardless of whether or not they satisfy a particular case. The weight of oil has been taken as 7.75 pounds per gallon (58 pounds per cubic foot).

With the above figures, the ratio of heating value of a pound of oil to a pound of coal becomes:

$$\frac{18{,}800 \times 0.75}{14{,}300 \times 0.69} = 1.43.$$

The following table gives the costs of oil per gallon, per ton and per barrel over a wide range, together with the cost of coal per ton corrected to the same heat contents and boiler efficiency as fuel oil. Thus, if coal is $6.08 per ton, it would be just as cheap to buy fuel oil at $8.70 per ton ($.03 a gallon), as the same amount of steam could be raised in each case for the same fuel cost. In other words, one is getting more available British thermal units in a ton of oil than in a ton of coal and hence would be justified in paying a higher cost per ton for the former. Both prices are for the fuel in the bunkers.

Oil per Gallon, Cents	Oil per Ton	Oil per Barrel	Coal per Ton Corrected to Same British Thermal Units and Boiler Efficiency as Oil
3	$ 8.70	$1.26	$ 6.08
4	11.55	1.68	8.07
5	14.45	2.10	10.10
6	17.35	2.52	12.15
7	20.20	2.94	14.15
8	23.15	3.36	16.15
9	26.00	3.78	18.20
10	28.90	4.20	20.20
12	34.70	5.04	24.25

Walter M. McFarland has given the following rule: When the cost of coal in dollars per ton is double that of oil in cents per gallon, the fuel costs of producing steam are equal. He assumed, no doubt, slightly different boiler efficiencies and British thermal unit values, but the above table bears out the rule.

Causes of Fuel Price Fluctuations

Prices of fuel today are fluctuating so rapidly, depending upon labor and transportation conditions or whether the fuel is bought in the open market or on contract, that any exact comparison is useless. At the time of this writing fuel oil is selling from 8 to 10 cents per gallon in the open market (contract prices are much lower), against $15 to $17 per ton for bunker coal; so as far as immediate market prices are concerned, costs of producing steam are about the same for the two fuels. With the decreasing supply of fuel oil, the cost is bound to keep on rising while the high cost of coal is more or less a condition of labor and transportation.

The first cost of the oil installation with the piping, heaters, pumps, etc., is greater than that for coal. There is also a small amount of steam required (about 1½ percent of the boiler output) to operate the oil pumps and heat the fuel oil, which is also unfavorable to fuel oil. On the other hand, the engine room force for an oil burning ship would be cut down about 30 percent, which is an important item in operating expenses. The life of the boiler will be longer and the maintenance costs less for fuel oil than for coal.

Bunker Space

Fuel oil occupies about 40 cubic feet per ton against 50 cubic feet for coal. Thus oil requires about 80 percent of the bunker space necessary for coal. If this is corrected by the difference in heat content and boiler efficiency, we have:

$$0.80 \times \frac{0.69}{0.75} \times \frac{14{,}300}{18{,}800} = 56 \text{ percent.}$$

In other words, the amount of oil necessary to produce the same amount of steam under the same conditions occupies about 56 percent of the bunker space required for coal. In addition to this, liquid fuel can be stowed much more conveniently than coal, and the double bottom and other places not accessible for coal can be readily used for oil. How much of this saving in bunker space can be used for stowage of cargo depends to a large extent on the design of the ship. An actual layout would have to be made to get comparative figures. It is evident, however, that there will be a very large saving in space available for cargo.

Relative Weights of Fuels

A comparison of weights of the two fuels is decidedly in favor of the fuel oil. As already shown, the ratio of weight is

$$\frac{14{,}300 \times 0.69}{18{,}800 \times 0.75} = 0.70.$$

This shows that fuel oil to produce the same amount of steam as coal weighs only 70 percent as much as the coal, or the coal weighs 43 percent more than the fuel oil.

The saving in fuel weight gives the oil burning ship a larger net deadweight carrying capacity. This is also accompanied by an increase in hold space as previously pointed out.

For a slow ship on a short voyage the saving in bunker space and fuel weight, and to a considerable extent fuel costs, may not be very important. However, as the length of the voyage becomes greater or speed is increased, both of the factors become of more and more importance.

Fuel oil is much easier and cleaner to handle on shipboard, and much easier and quicker to put in the bunkers, and results in a much cleaner ship. The difference in comfort in the fireroom is beyond comparison.

Availability and Future Supply of Oil

From the above analysis it appears evident that with the present prices of fuel the only one to consider is fuel oil. Even with the price of oil higher per ton than coal, the factors of space, weight, reduced crew, and convenience of handling, would still give oil by far the advantage.

There are, however, two other factors of greater importance than those given. The first is the possibility of fueling an oil burning ship at the various ports of call, and the second and most important of all is the question of the future oil supply of the world.

Geologists of high rank tell us that at the present rate of consumption the world's supply of petroleum will be falling off rapidly in 10 or 15 years. With this rapidly decreasing supply of petroleum and the increasing demands for gasoline and fuel oil, the price of fuel oil is bound to rise rapidly. Another factor that will increase the price will be the demand of fuel for use in the Diesel engines of the world's growing fleet of motorships.

On account of the much smaller fuel consumption of the Diesel engine, the motorship will be able to operate long after the oil burning steamship has ceased to be an economical ship. A study of the table given at the opening of the article would lead to the conclusion that when oil reaches a value around 10 to 12 cents a gallon the coal burning ship would be more economical than the oil burning ship, especially if the price of coal is reduced due to improved labor and transportation conditions.

Steamship companies and many power plants on shore are today ordering and installing oil burning boilers and changing over existing installations from coal to oil burning. Even apartment houses and hotels are following in this wave of oil burning and are fitting oil burning equipment.

If we are to accept the figures of the geologists, it would seem that the present tendency with regard to fuel oil burning is not altogether in the right direction. Certainly, power plants and industrial installations on shore that are not affected by the weight and space requirements of a ship and to a considerable extent the boiler room and handling difficulties cannot long continue to use fuel oil.

Passenger ships and naval vessels can afford to use oil on account of its cleanliness and ease of handling long after cargo ships have found it uneconomical. For the present, and as long as fuel oil is available, ships requiring horsepowers not greater than 6,000 to 7,000 will prove far more economical with Diesel engines than with steam installations, as will be pointed out later. For the cargo carrying steamship and high powered passenger ship, it would seem that the proper solution is a return to coal fired boilers and the adoption of the mechanical stoker. The failing supply of fuel oil should be reserved entirely for naval vessels, medium powered passenger ships and Diesel engined motorships.

Mechanical Stokers

The mechanical stoker so far has been practically untried on shipboard, although it is giving excellent service in power plants on shore. The efficiency of a boiler fitted with a stoker is nearly the same as when using fuel oil. The steam necessary to operate the stoker would not greatly exceed the 1½ percent required for a fuel oil installation. Further, the labor expense certainly would be nearly as low as that for fuel oil. Stokers will involve some increased weight and space and the boilers will have to be raised. These factors, however, should cause no serious difficulties, especially with watertube boilers operated at the higher rates of combustion possible with mechanical stokers.

With improved bunkering facilities such as the Michener bunkering machine, much of the dirt and expense of bunkering could be eliminated. Mechanical conveyors could be installed for handling coal from the bunkers to the stoker, and mechanical bunker trimmers could also be used for trimming the coal in the bunkers. It is interesting to note that the methods of handling coal today on shipboard are practically the same that were used on the first coal burning steamship.

Comparative tests have been made on shore with the Emergency Fleet Corporation's four pass watertube boiler, both hand fired and with underfeed stokers. At a rate of combustion of 20 pounds of dry coal per square foot of grate surface the efficiency based on dry coal was roughly 71.5 percent for the hand fired boiler and 75 percent when fitted with mechanical stokers.

Mechanical stokers certainly have much in their favor and deserve more study and trials on shipboard than they have so far received.

Diesel Engines

This paper on fuel would not be complete without some mention of the Diesel engined motorship. The motorship is rapidly replacing the cargo steamship of 15,000 tons deadweight and under and will probably in the near future completely supersede it. This is, of course, due to the small fuel consumption of the Diesel engine, although the machinery weights and first costs are greater for the motorship.

Allowing a fuel consumption for the Diesel engine of 0.40 pound per shaft horsepower per hour, and for the oil burning steamship of 1.00 pound per shaft horsepower per hour, which is more than favorable to the Diesel ship, the fuel ratio becomes $\frac{1.00}{0.40} = 2.5$. The coal burning ship (hand fired) would have a consumption of 1.43 pounds per shaft horsepower per hour, if we use the same values of British thermal units and boiler efficiency as before.

These figures give the following results:

1. Fuel for a motorship weighs about 28 percent of that for a coal burning steamship and 40 percent of that of an oil burning steamship.

2. Fuel for a motorship occupies 22½ percent of the bunker space required for a coal burning steamship and 40 percent of that of an oil burning steamship.

When we stop to consider that the fuel for a coal burning steamship weighs 3.6 times and occupies 4.5 times the space that the fuel for a Diesel engined motorship does, we at once realize the tremendous saving in fuel cost and weight, and bunker space for the motorship.

A more complete comparison of the steamship and motorship will be given in a later paper.

Possible Fuels of the Future

In this comparison we have considered only the existing fuels and have made no allowance for the possibility of new kinds of fuel and new methods of burning fuel. A few of these possibilties should receive attention.

The first of these is pulverized coal which today is being adopted in many land installations and bids fair to be one of the most important fuels of the future. The lower grades of coal can be used for pulverizing and the cost of pulverizing and delivery to the boiler does not appear to be excessive. The danger of explosion, it is claimed, has practically been eliminated, so this former objection is apparently not pertinent today. It is handled in much the same manner as liquid fuel, is very flexible and gives as high a boiler efficiency as

fuel oil. Operating expenses, including crushing, drying, pulverizing, maintenance and depreciation of equipment, etc., are claimed to be less than with mechanical stoker installations.

Whether this fuel can be used satisfactorily on shipboard is questionable. On account of the large volume occupied by pulverized coal, it is not feasible to carry it in pulverized form in the bunkers. This would necessitate, then, a crushing, drying and pulverizing plant on shipboard which would require additional space, weight and added complications. While the fuel has attractive features for stationary plants and is bound to be widely adopted in place of hand firing and mechanical stokers, it probably will not be introduced on shipboard until more compact methods of crushing and pulverizing the coal have been devised.

Another new type of fuel that appears very attractive for use on shipboard is colloidal fuel. This fuel is a stable liquid fuel which consists of a mixture of pulverized coal and liquid hydro-carbons, about 40 percent coal by weight.

Colloidal fuel has been tried under boilers and has shown as good a boiler efficiency as fuel oil and can be used with the regular oil burning equipment.

An interesting article on colloidal fuel by L. W. Bates appeared in the *National Marine* for July, 1920, from which I will quote:

"One may summarize the situation regarding colloidal fuel as follows: It may be made with the smaller sizes of coals too fine to be fired on grates. Thus earth crushed anthracite and washings from rivers may be utilized. A patented process of ash removal permits the use of large and poor culm banks. Lump sizes of coal are not required, as the wastes and dust when pulverized are equally useful. It is the most compact fuel known. Whereas oil contains about 148,000 British thermal units per gallon, an average grade of colloidal fuel, made with bituminous coals, contains 160,000 British thermal units and grades may be made containing over 180,000 British thermal units per gallon. The liquid used in colloidal fuel may be a blend of several oils and may include the tars. In colloidal fuel 20 percent of such tar or 30 percent of water gas tar combined with pulverized coal may be stabilized in mineral oils. In regard to cost, colloidal fuel can compete with straight oil when the cost of oil is over 2 cents a gallon and coal at its usual prices. With oil at 10 cents and tar at 5 cents per gallon and coal wastes at $3 per ton, straight oil is 50 percent dearer than colloidal fuel made with the above materials. Since colloidal fuel is heavier than water, it will sink in it and so may be stored under water seal and thus made fireproof. A fire consuming the fuel may be quenched with water."

It certainly seems that the possibilities of this new fuel are very great, especially in those countries that have no oil, as a liquid fuel can be produced, 50 percent oil and 50 percent pulverized coal.

Future developments may bring new fuels and find ways of producing fuel oil such as from shale and the low temperature distillation of coal. Colloidal fuel mentioned above suggests one new and important development. Barring these developments, however, it appears that the day of the coal burning steamship has not passed. For the immediate future all ships requiring less than 6,000 shaft horsepower should be fitted with Diesel engines. While the fuel oil is available at a reasonable price, low powered cargo and passenger ships using steam machinery will be unable to compete with the motorship.

JAMES ROWLAND BIBBINS has been made manager of the newly created department of transportation and communication of the Chamber of Commerce of the United States. Mr. Bibbins was educated in Baltimore City College and at the University of Michigan. He has had wide experience in consulting work dealing with transportation problems in many cities throughout the United States and Canada; he has studied terminal and transit problems in New York, Chicago and other large American cities, and is especially qualified to deal with the problems confronting this new department.

Geared Marine Turbines*

BY C. R. WALLER†

THE first geared turbine used for ship propulsion was built in England in 1909 and installed on the S. S. *Vespasian*. Previous to this, reduction gears had been used for many years in connection with high-speed turbines driving electrical machinery, as well as centrifugal pumps and blowers. The first marine-geared turbine built in this country was produced in 1911, and from that time on hundreds of equipments have been made and installed on board different types of vessels.

When judging the merits of a propelling unit, it must be considered in reference to reliability, economy of operation, and economy of installation.

RELIABILITY

Of the several hundred geared marine turbines built during the last few years there has been considerable trouble, chiefly with the reduction gears. It has been stated on many occasions that most of these troubles have been due to the fact that the equipment was built during war conditions and that material and workmanship were not up to par.

While some of the failures may have been due to conditions caused by the war, there are numerous failures due to other reasons. Trouble with gear reductions has not been universal; many have not given trouble, showing conclusively that the failure of a great many gears must have been due to the design. This is unquestionably true when we consider that some of the latest designs are considerably different from the early designs.

With the experience gained by the different companies producing marine gears, I feel confident that most of their early gear troubles will be eliminated and that we can look forward to future designs that will be entirely reliable in their operation.

ECONOMY OF OPERATION

The geared turbine of the latest design is unquestionably the most economical propelling unit built. There is a very slight difference between the economy that can be obtained with a turbine on board a vessel as compared with land turbines; and with the present development in boiler designs, there is no reason why we should not look forward to having ships operated with as high economy as some of our modern power plants on shore.

The main loss between the turbine and the propeller is, of course, the gear reduction in connection with geared turbines and the generator and motor losses in connection with electric drive. The efficiency of a good gear reduction can be conservatively given as 98½ percent for the single-gear reduction and 97 percent for the double-gear reduction, whereas the equivalent efficiency of the electric drive will be 93 percent. For ships like tramp vessels going under full power from port to port, this difference in economy is of course important.

ECONOMY OF INSTALLATION

Under this heading should be considered the first cost of the equipment, as well as the weight and space occupied by the equipment. The geared turbine is a cheaper equipment than the electrical equipment and it can safely be stated that the electric drive for marine propulsion for an average size freight vessel would cost about 20 percent more than a similar equipment of the geared turbine drive. The weight of the electric drive equipment would be approximately 12 to 15 tons above that of the geared turbine drive.

---

* From a lecture delivered before the Ocean Marine Engineers' Beneficial Association No. 80, New York, March 15, 1921.

† De Laval Steam Turbine Company, Trenton, N. J.

Motorship Building in Europe Increases

BY OUR SPECIAL LONDON CORRESPODENT

While it would not be correct to say that the development of motorship building has remained unaffected by the general shipping and shipbuilding depression, there is no doubt that European shipowners are much more inclined to proceed with the construction of internal combustion engined vessels than steamers. This is borne out by the fact that, while large numbers of steamships have been cancelled and work on many others slowed down, in practically every case shipbuilders have orders to proceed as rapidly as possible with the completion of motorships.

LLOYD'S returns for the quarter ended March 31 show that at the end of that period there were actually more motorships building than at the end of December, 1920, whereas the number of steamers under construction had diminished. In Europe there are now 194 motor vessels actually being built with a gross tonnage of over 500,000, in addition to which many more have been definitely contracted for and will be laid down in the near future. Of this number Great Britain is responsible for 66 totalling 263,180 gross tons, showing that in motorship building British shipbuilders are anxious to play a leading part.

What is perhaps more important from the technical standpoint is the number of new types of engines which are being built and the large amount of experimental work now being carried out. This is all the more significant in view of the fact that almost without exception Diesel engine builders have adopted standardization so that they would not interfere with their normal design, unless they see some great advantage is likely to accrue.

A good instance of this is shown in connection with the North British Diesel Engine Works, whose latest engine has just been completed and will be referred to later. Although in the meantime standardizing a four cycle type they are very actively engaged in experimenting with double acting two stroke motors which they look upon as the ultimate solution of the marine motor problem. They are now building their first experimental set of this type, and it is believed that it will mark a great advance upon existing practice. In particular they believe they have overcome one of the main objections to the double acting engine (which is to be found in the Blohm and Voss design, by providing for the admission of fuel in the center of the cylinder in spite of the obstacle of the piston rod. Blohm and Voss in their latest engine have reverted to the idea originally adopted by Krupps in employing two piston

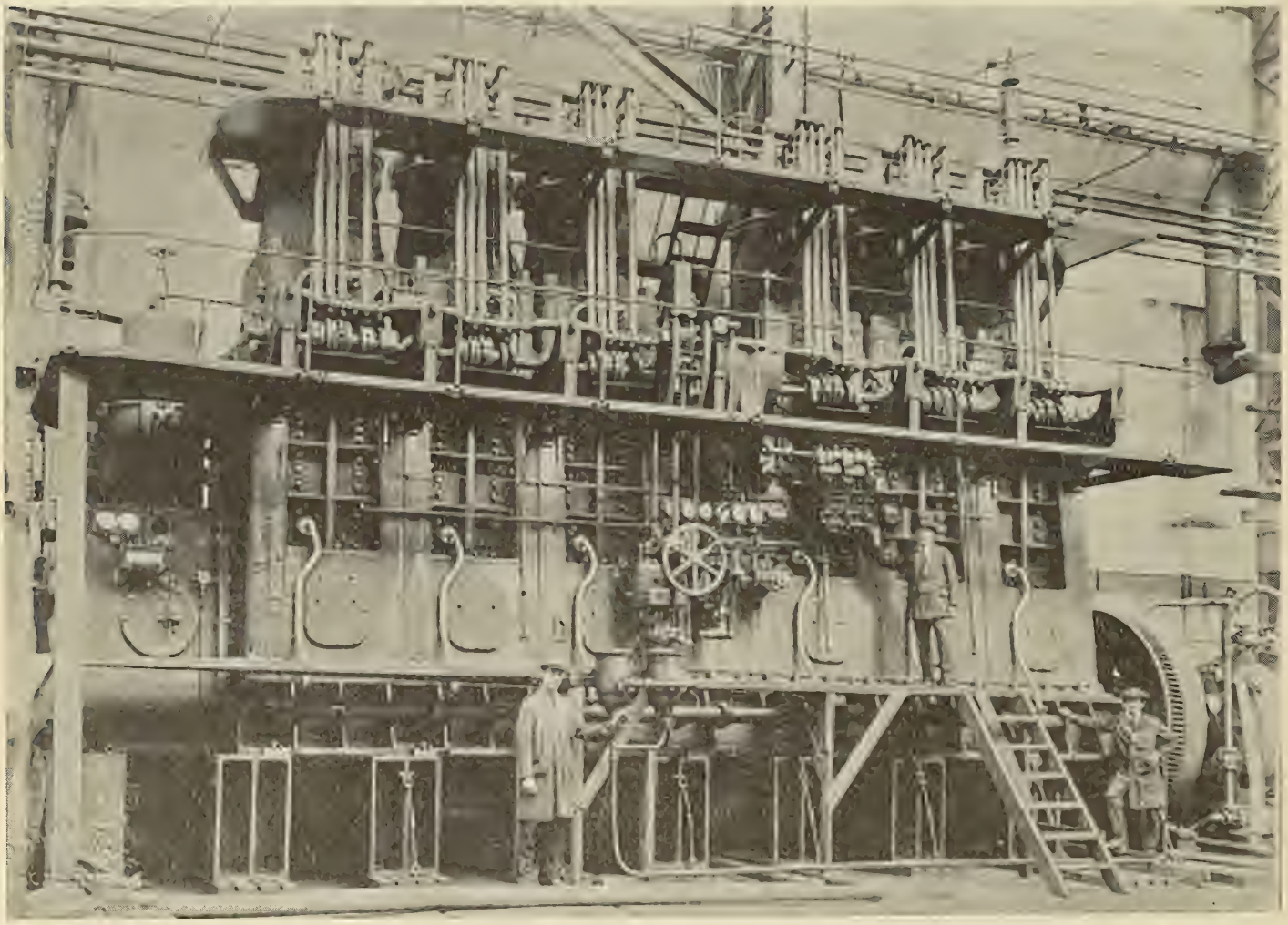


Fig. 1.—One of 1,600 Indicated Horsepower Harland & Wolff Engines for Installation in Motorship *Lobos*, With Electric Motor for Reversing

rods with fuel valves between them. It must be admitted that this seems a somewhat clumsy means and must necessarily add to the expense of construction.

Long Stroke Engines for Single Screw Ships

Harland and Wolff, who have based the organization of their remarkable works at Glasgow on the policy of building only two types of standard Diesel engine, have also gone on somewhat new lines and are now constructing their first long stroke motor, intended for installation in single screw cargo ships. Hitherto all vessels constructed by this firm have been twin screw craft and the new development is mainly due to a demand on the part of shipowners for single screw vessels which naturally are somewhat cheaper to build and less expensive to run. It is not likely that Harland and Wolff will break away from their standard practice, but they realize that the single screw vessel represents a demand that must be met. This long stroke engine is mainly remarkable for its slow speed, running at about 85 revolutions per minute, and having a cylinder with a stroke approximately twice the bore. In other features it will be similar in design to the higher speed type.

The same builders are also departing from standard practice in a minor matter and are now offering shipowners a Diesel engine in which the reversing gear is actuated from an electric motor instead of a compressed air engine. One of the engines in which this new arrangement is adopted is illustrated in Fig. 1, showing the starboard set installed in the new motorship *Lobos,* for the Pacific Steam Navigation Company. The method of drive can be noted from this reproduction, the vertical electric motor being indicated in the center of the engine and replacing the vertical air and oil cylinders which are usually fitted.

This electric motor gives the reversing mechanism the necessary movement and the principle of operation remains unaltered. The cost of the electric system is rather higher than the normal design, but some shipowners prefer it on account of the fact that it is independent of the pressure of the air supply. One objection to the air system is that, if the air pressure is lowered, due to frequent maneuvering having taken place, the time of reversal is increased in a progressive manner so that just at the period when quick reversal is required it becomes slower and slower. Naturally this should not happen, if the engineers are on the alert and do not let the air pressure drop, but one cannot always guarantee that this will be the case.

A Steam-Oil Engine

A further important technical development in connection with marine oil engine design remains to be recorded. This is that the Still combined steam and oil engine has now reached a commercial stage and Scotts Shipbuilding and Engineering Company, the licensees for the construction of this unusual type, have decided as a result of nearly a year's experimental work to proceed with the manufacture of Still engines, for installation in motorships. Their experimental engine, shown in Fig. 2, is a single cylinder set and the engines that will now be built will be of exactly the same design, but with six cyclinders instead of one, developing about 2,100 brake horsepower at 120 revolutions per minute.

The engine that Scotts have built is an ordinary two cycle Diesel motor, with the lower half of the cylinder below the piston acting as a steam engine. The steam is raised from the cylinder jackets and the exhaust gases, the circulating water being kept at about 400 degrees F. At this temperature it circulates around a boiler, steam being given off at about 120 pounds per square inch, and delivered to the under side of the pistons; thus adding a certain amount to the power developed. This is indicated by the fact that the cylinder which develops 350 brake horsepower has a diameter of only 22 inches and a stroke of 36 inches. The fuel consumption is stated to be 0.35 to 0.37 pound per brake horsepower hour, which is, of course, a good deal lower than any other type of Diesel engine on the market.

The Still motor is complicated by the addition of the steam plant, and it would seem that it must be more costly to build than an ordinary Diesel installation. However, there appears to be some doubt on this point and the builders claim that if everything is included there is not much difference, since steam is in any case required for operating the auxiliaries. The engine starts and reverses on compressed air, so that the ordinary Diesel reversing and starting gear is eliminated. The installation of the first Still engine in a large ship will be watched with interest and the fact that such well-known shipbuilders as Scotts Shipbuilding and Engineering Company have taken up the construction will augur well for its future.

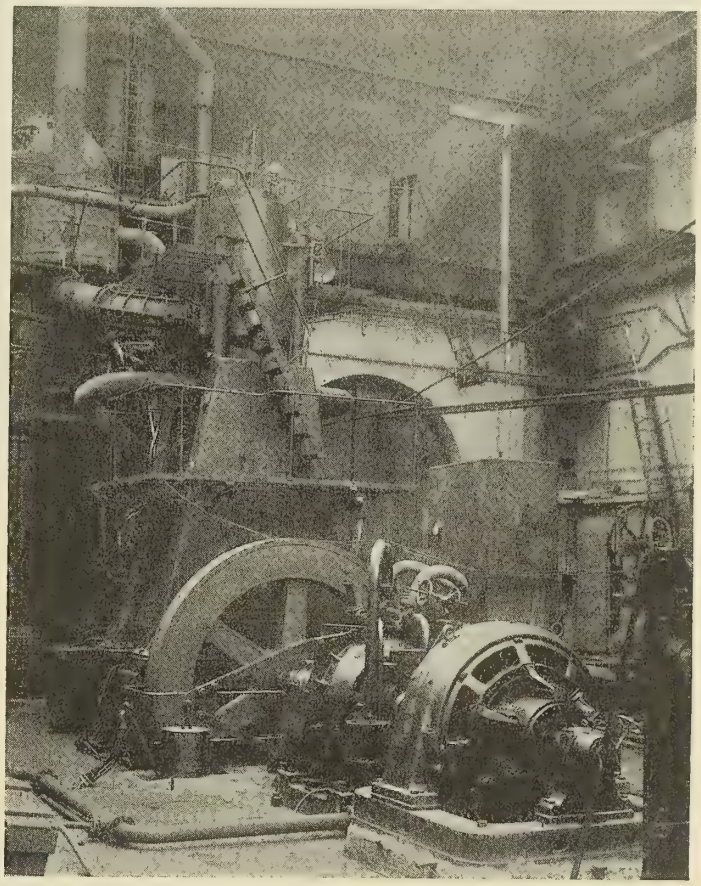


Fig. 2.—350 Brake-Horsepower Still Combined Steam and Oil Engine

New Machinery for Passenger Liner

Although we have had to wait a long time for the first motor passenger liner to make its appearance, it will now probably not be long before it is completed. The twin screw machinery is being installed in the motor passenger liner *Domala,* for the British India Steam Navigation Company, and shipowners and shipbuilders are watching this ship with the very greatest interest, as it is realized that a great deal depends upon its satisfactory operation.

The two engines, of which an illustration is given in Fig. 3 showing them on the test bed, have been built at the new factory of the North British Diesel Engine Works, Ltd., Glasgow, and are of their own design. They are of the four cycle type, having eight cylinders 26½ inches diameter and 47 inches stroke, developing 2,300 indicated horsepower at 96 revolutions per minute.

Although they are of new design, there is nothing very unusual in their construction except for the fact that the air compressors are separately driven and that a novel method

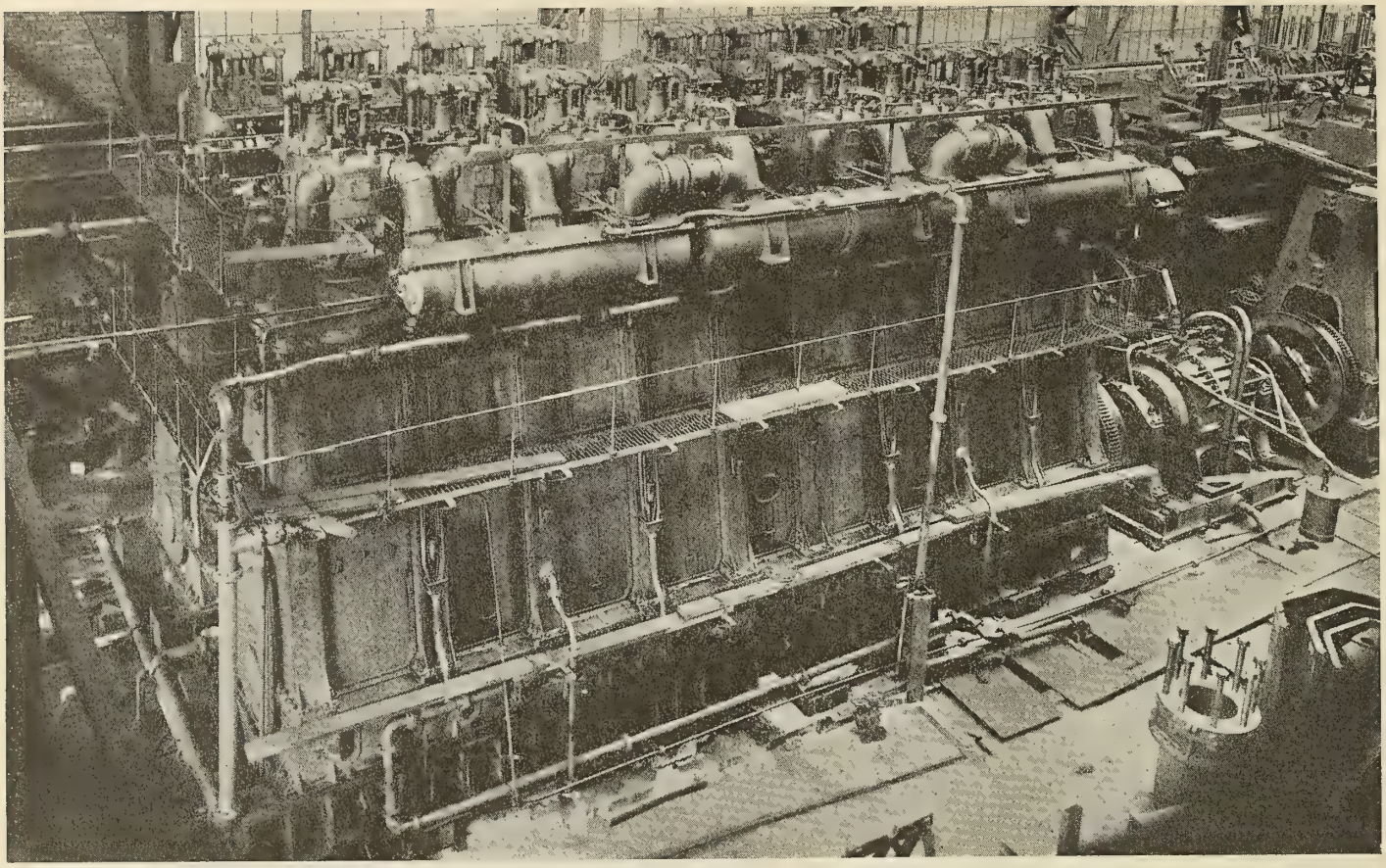


Fig. 3.—Twin Screw 4,660 Indicated Horsepower Machinery of the Motor Passenger Liner *Domala*

of reversing has been effected by lowering the whole camshaft before giving it the usual longitudinal movement to bring the astern cams into operation. This system, however, was probably employed mainly to avoid infringing any existing patent and on the whole does not appeal quite so much to the engineering mind as the more common arrangement of raising the valve levers above the camshaft before the latter is moved. Probably it would be difficult to improve on the Burmeister and Wain principle in this direction, and as it is understood that the patent for it has run out, possibly many manufacturers will adopt it as their standard.

In the motor passenger ship *Domala,* the injection and starting air compressors will be driven by separate Diesel engines, each developing 400 brake horsepower, and as two 300 brake horsepower Diesel driven generating sets are also fitted in the engine room, it will be understood that a very large amount of machinery is required. It is perhaps not surprising that the owners in their second ship have decided to fit the injection air compressors on the main engine, thus eliminating part of the auxiliary plant.

New Orders for Motorships

It is significant that Continental shipowners (even Scandinavians) are now coming to Great Britain for their ships and none of these shows signs of curtailing its programme in view of the present position. For instance, the Transatlantic Steamship Company of Gothenburg has announced a programme of six motorships to be delivered within the next two-and-a-half years; three of these are to be built in a British shipyard and are to have Doxford Diesel engines. The Holland American Line is having two 14,000-ton motorships built by Harland and Wolff, while several motorships are being constructed in British yards for Norwegian shipowners. Briefly it may be said that in spite of all detrimental influences, the future of motor shipping never looked more hopeful than it does at the present time.

The Volund Heavy Oil Engine

Although comparatively new in this country, the Volund heavy oil engine has had many years of successful operation in Europe. It is built in Copenhagen, Denmark, by the Volund Company, and handled in the United States by the MacBee Company, New York. The engine is of the two stroke cycle, valveless, crank case compression, trunk piston type. The cylinder is of special cylinder steel cast as a unit with its water jacket. The trunk piston is fitted with five piston rings at the top for tightness, and one near the bottom to retain and distribute the lubricating oil on the cylinder walls, and is linked to the connecting rod by a case-hardened piston pin, ground to finish. The crank shaft is made from a single forging, in one piece, with complete crank disks and counterweights. Mounted on each cylinder is a mechanical forced feed lubricator, which provides positive lubrication for the cylinder and for each of the bearings.

The sizes in which Volund engines are constructed range from a single cylinder engine developing 5 horsepower at 550 revolutions per minute to a six cylinder engine which developes 480 horsepower at 220 revolutions per minute. For marine use, the engine is fitted with a limit governor, to prevent racing of the propeller; the stationary types have inertia governors, which give close regulation for electric generation and other power purposes.

Special Ignition Features

While the engine is generally said to be of the surface ignition type, an examination of its construction and operation will show that the ignition is not a pure surface ignition. The hot bulb is a complete oval, with the upper part exposed to the atmosphere, while the lower part, contrary to common practice, is exposed to the compression space in the top of the cylinder. This lower face is pierced by a small opening. With combustion beginning in the bulb and completed in the

entire space, the lower walls of the bulb are heated very intensely. The combination of the high temperature of this wall, and the small size of the opening, results in a strong heating effect on the air passing through the opening during compression. Added to this, compression itself raises the temperature of the air, so that a temperature of about 1,100 degrees F. is reached within the bulb before the fuel is injected. This makes the ignition of the fuel take place from the temperature of the air, just as in the pure Diesel engine, although the high temperature is attained by different means. Ignition occurs before the fuel has time to reach the hot surface. As soon as combustion has begun, the expansion of the gases within the bulb causes a violent discharge of the burning materials into the top of the cylinder, which gives thorough and quick mixing, and complete combustion, resulting in economy of fuel and smokeless exhaust.

For starting, the blow lamp does not heat the hot bulb, but only a small ignition tube, which causes the first few ignitions, until the combustion within has heated the bulb, after which the blow lamp is extinguished. Starting tests described in a Danish Government report on a two cylinder Volund engine showed that nine to ten minutes was sufficient for starting the engine, measuring time from the instant of lighting the blow lamp on a perfectly cold engine.

The marine type is made, in large sizes, with a direct reversing system, which is accomplished by an early injection of fuel, which gives an explosion in the reverse direction, after which the timing of all events is automatically made correct for the reverse direction. The small size engines are provided with either reversing propeller or with reversing gear. These systems of reversing refer to quick maneuvering, as all of these engines can be started in either direction from stationary condition by compressed air. Danish Government tests on the reversal of the engines resulted in ten changes from ahead to astern and ahead within a period of sixty-five seconds, or an average of six and a half seconds per reversal.

Fuel Consumption

The range of fuels applicable to the Volund engine is quite wide, from any of the light oils to Diesel oil and many grades heavier. As to fuel consumption, this engine stands very well in comparison with others of this simple, rugged type. The guarantees of the builders are conservative and are considerably excelled in operation. The test by the Danish Government of the 80 horsepower two cylinder engine, already referred to, shows a fuel consumption of 0.505 pound per horsepower hour at full load and 250 revolutions per minute on crude oil of a specific gravity of 0.86.

In the lighthouse service of the Danish Government these engines have been used, to the exclusion of all others, for lightships, lighthouse tenders and cutters, and as stationary power for lights and fog horns. This speaks strongly for the feature of reliability. They have been applied to tugs, both harbor and ocean, fishing boats, trawlers, work boats, auxiliary schooners, power barges, pleasure craft, and to cargo and passenger boats for coastwise, channel and Baltic Sea service, as well as to auxiliary generator and compressor sets for large vessels.

Standardized Diesel Engines—IV*

Description of Engine With Automatic Valve Port Scavenging Arrangement—Simplified Valve Gear

BY H. R. SETZ

A PORT scavenging engine in the design of which the best accumulated observations have been utilized is outlined herewith. Identically the same frame structure is here used as previously described, and the only parts that differ are the cylinders, the lower cylinder rings and the cylinder heads (see Figs. 16, 17 and 18).

The cylinder barrel is cast integral with what corresponds to the upper centering flange or cylinder ring of the four cycle engine, thereby obviating the necessity of a rather unfavorable cylinder support at its upper end owing to the large bore which a separate cylinder ring would require to let the enlarged lower end of the cylinder through. The need for this enlarged lower cylinder end arises from the fact that a certain radial depth of material is required to accommodate exhaust and scavenging ports of suitable form, as well as water passages between these ports. The lower cylinder end is again slid into a centering ring which here takes the form of a water cooled exhaust belt over approximately one-half its circumference, while the other half contains scavenging air passages.

The same scraper rings and cored drain space for collecting combustion refuse as were previously described form the bottom end of the cylinder. All the advantages of freedom for lateral adjustment for each individual cylinder and elimination of boring in the cylinder beam are retained.

Like the valve-in-head two cycle engine, the exhaust from each cylinder is carried from the exhaust belt by means of a water cooled outlet through the side of the cylinder beam to a common exhaust header. The weight of the exhaust outlet and possible vibrations in the whole discharge line are taken off the joint at the cylinder belt by the provision of a flange slidably fitted over the exhaust outlet and fastened against the cylinder beam after all exhaust line connections have been made. Incidentally, this also facilitates forming an airtight joint where this exhaust outlet passes through the cylinder beam. The open underside of the latter is closed off by light steel plates, the outer edges of which are fastened against longitudinal and transverse flanges on the beam, while their inner edges are secured against the lower end of the cylinders. In a most natural manner the interior of the cylinder beam thus becomes a receiver space of very liberal proportions by means of which scavenging air can be conducted to each cylinder with a minimum of flow resistance. The complete surrounding by this scavenging air space of the cylinder belt containing the various ports lends itself to a splendid adaptation of the port scavenging principle.

Control Element

Reference to the transverse horizontal section in Fig. 18 shows the circumferentially disposed scavenging ports in the cylinder and their co-relation with radial passages through the cylinder belt. Each of these passages is provided with a control element the function of which is to check communication between the scavenging air receiver space and the interior of the engine cylinder during that short interval after the piston first uncovers the scavenging ports until pressure release has taken place through the exhaust ports. Enlarged views

* Copyright, 1921, by H. R. Setz.

of such a control element are given in Fig. 19. It comprises four flat, narrow strips *A* of ordinary spring steel, lightly held against the flat face of cage *B* by springs *C* in the retainer *D*. These steel strips or check valves open inwardly, their lift being limited by retainer *D*. They permit flow only into the cylinder, as soon as the pressure in the latter drops below that of the scavenging air in the surrounding receiver space, and return to their seats at the least tendency of the flow to reverse.

From this it will be observed that the action of these valves is entirely automatic. Owing to the narrowness of the passages in cage *B* which they control, with the resulting shortness of unsupported span, the load conditions to which these check valves are exposed can easily be met with very thin steel strips, which as a consequence become extremely light in weight; their response to the slightest pressure difference is practically instantaneous. Positiveness of their action is furthermore assured by the very small lift required to uncover the full passage area through cage *B*.

In their construction these valves are practically identical with what in modern air compressor practice are known as "feather valves," which also consist of long, flat steel strips controlling air passages in the form of narrow slots. Similarly their action closely corresponds to that of the "feather valves" except that the latter are usually exposed to higher pressures and also less favorable temperature conditions than in the present application. This applies particularly to air compressor discharge valves which not only have to stand practically continuously the full delivery pressure, but also are exposed to the high temperature as the compressed air flowing past them when being discharged from the cylinder. When used as check valves on scavenging ports a stream of cool air only flows past these valves. Even during the short interval preceding pressure release through the exhaust ports their location at the end of what is at that moment a deep, dead pocket, together with the protection afforded by retainer *D*, prevents them from coming into direct contact with the hot gases of combustion.

Control Arrangement Simple to Manufacture

Attention is called to the admirable simplicity of this scavenging port control arrangement from the manufacturing point of view. The facility for delivering scavenging air to any point around the circumference of the cylinder by virtue of the latter being surrounded by the liberal receiver space makes it possible to give the scavenging ports the form of short radial passages through the side walls of the cylinder. These passages being all alike in section and radial length, and uniformly spaced circumferentially, the cylinder castings become greatly simplified and considerably easier to make than is the case on some recent two cycle engine cylinder constructions. No exceptional finishing processes are required, the only machining operation called for being that of milling the flat end faces on the outside of the cylinder wall. Likewise the parts of the scavenging valves, i. e., cages *B* and retainers *D*, require only plain milling. It should be noted that these parts are of a form which permits their being machined by the process known in modern

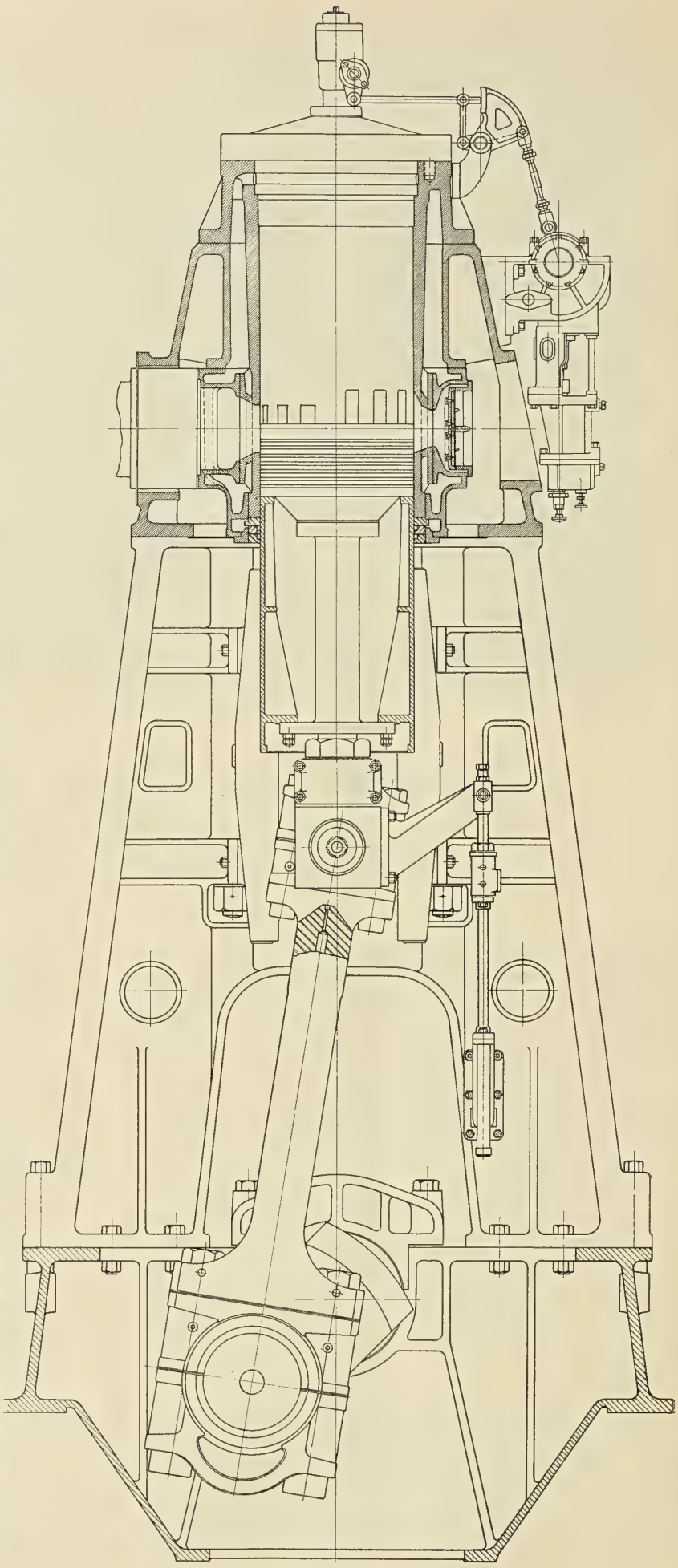


Fig. 16

STANDARDIZED DIESEL ENGINES

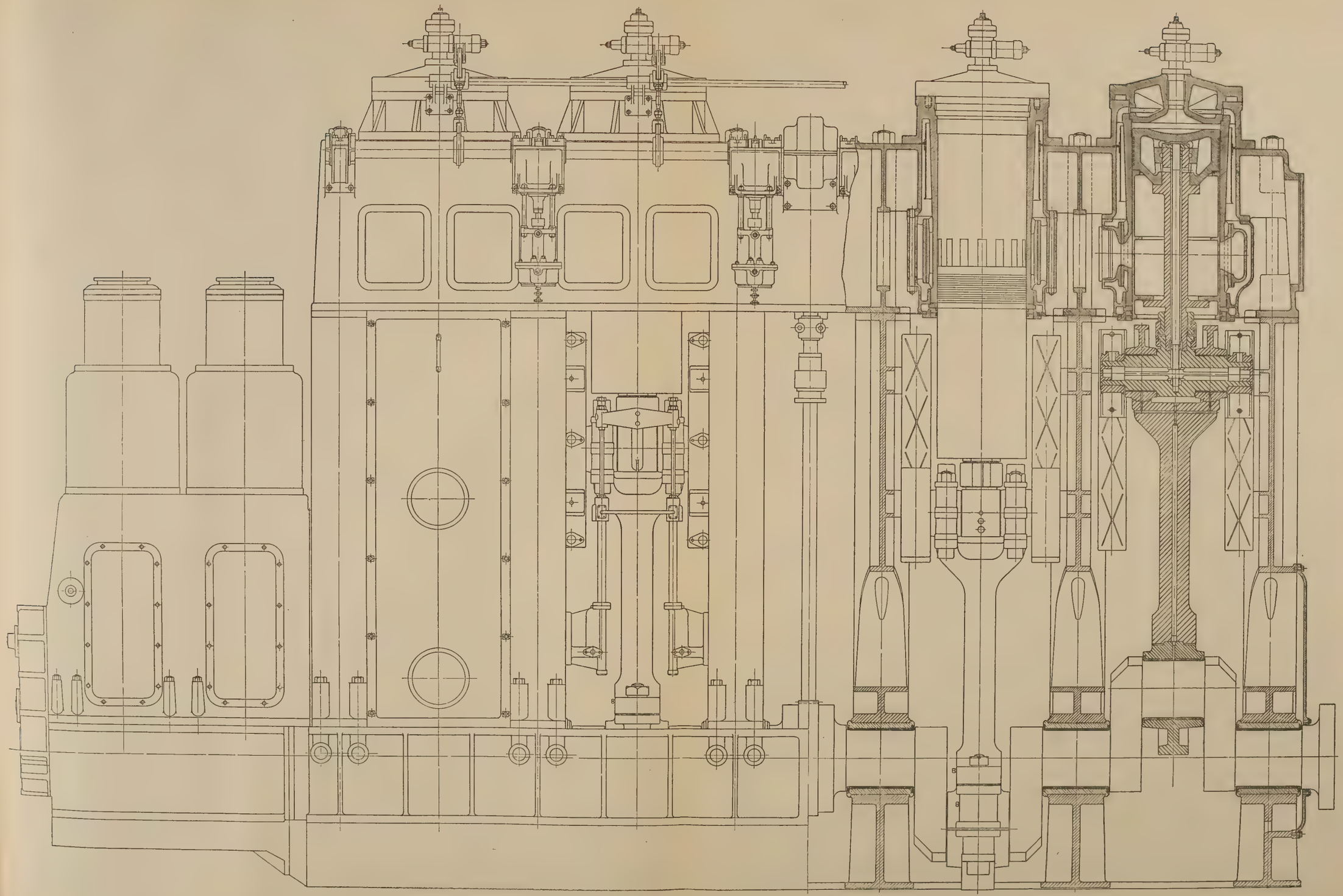


Fig. 17

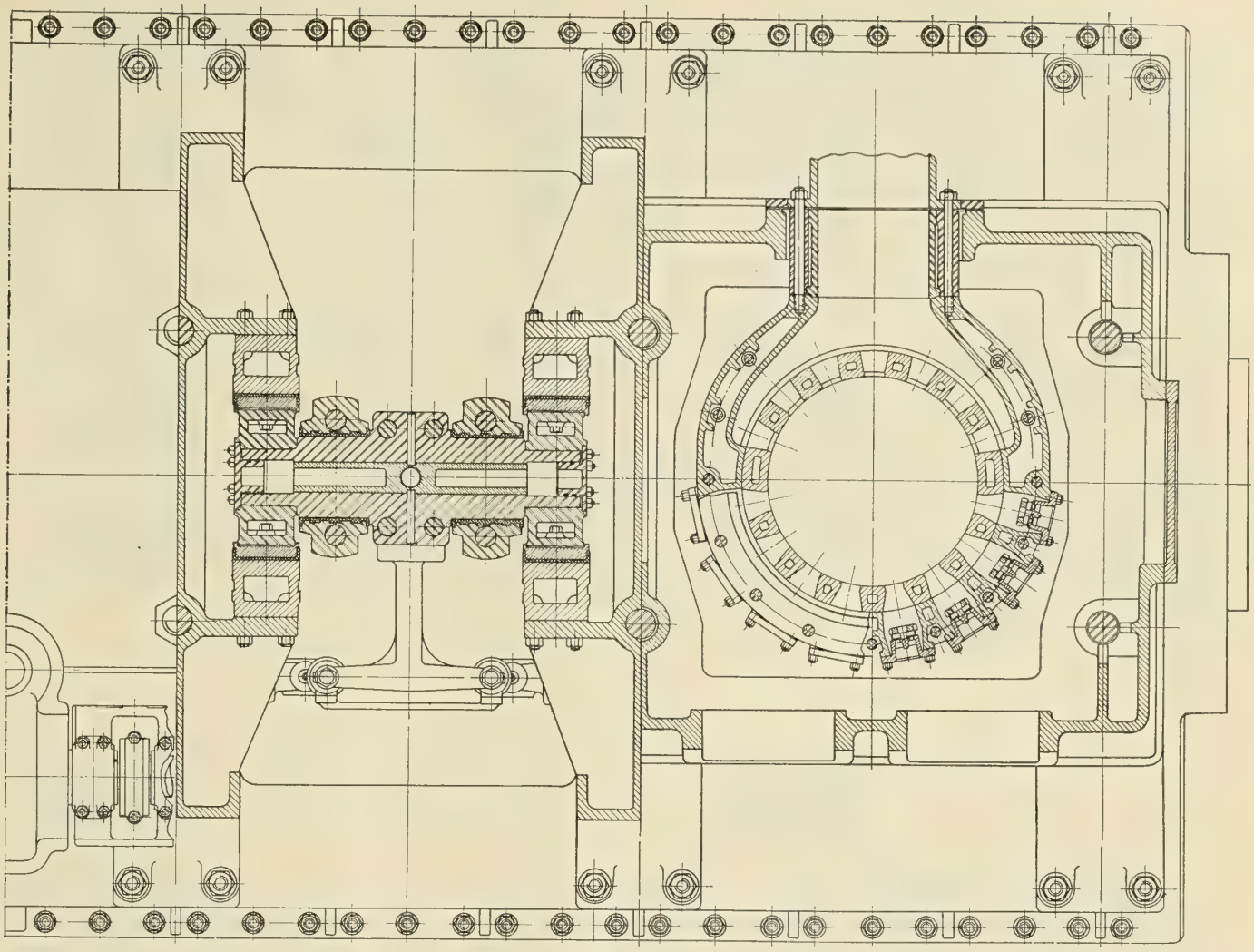


Fig. 18

manufacture as continuous milling. This, together with the fact that the material used is cast iron, reduces the cost for these parts to an almost negligible quantity, especially since they are not subject to any wear whatsoever. The only parts that could possibly require occasional replacement are the valves themselves, which, as compressor experiences show, is an insignificant item.

These valves are easily accessible through large openings in the side of the cylinder beam, only light sheet metal covers being used to close off the latter. Owing to the provision of individual control valves in front of each port, any one of the latter can be closed off entirely if desired without affecting delivery of a full stream of scavenging air through the other ports.

Comparative Study of Port Scavenging Systems

Lest it be thought that the constructive and mechanical advantages just described have been the only incentive for their adoption, a study of the diagrams in Fig. 20 is invited. The sketches at the left indicate the particular system of port scavenging that is to be discussed and the curves on the right show the inlet and exhaust areas made available in each. In all the diagrams abscissae represent piston travel and ordinates are proportional to areas. The curved lines beginning near the upper left hand corner of the diagrams is the end or "toe" of a two cycle indicator card and is the only line which measures pressures. In all cases the double cross-hatched areas represent exhaust port openings and the spaces filled in with vertical line shading show the net maximum areas available for the passage of scavenging air. Although the curves are approximate, they have been drawn as nearly as possible to the same scale and form a convenient basis for the comparative study of the various types of port scavenging which they portray.

Diagram *A*

At *A* is shown the most elementary type of port scavenging, in which inlet ports lower than the exhaust ports are used. The short scavenging period and small scavenging port area make it necessary to resort to high scavenging air pressures, in order to attain anything like the requisite velocities. High air velocities are objectionable on account of too turbulent scavenging, and because they make necessary a large excess volume of air to make up for the resulting appreciable loss through the exhaust ports. All this calls for a large scavenging pump and excessive negative work. A further loss of air results from the early closing of the scavenging ports, permitting the air pressure in the cylinder to drop until the piston covers the exhaust ports, when compression begins with the low initial pressure P_1. These phenomena account for the fact that engines of this type have an output 20 to 25 percent lower than more modern types of two-cycle engines and also are less efficient.

Diagram *B*

A much more favorable method of port scavenging is that where a row of valve controlled scavenging ports is superposed over the single row just described, placing the top edge of this second row higher than that of the exhaust ports. Diagram *B* permits of a detailed tracing out of the various phases of this scavenging cycle. Uncovering the upper row

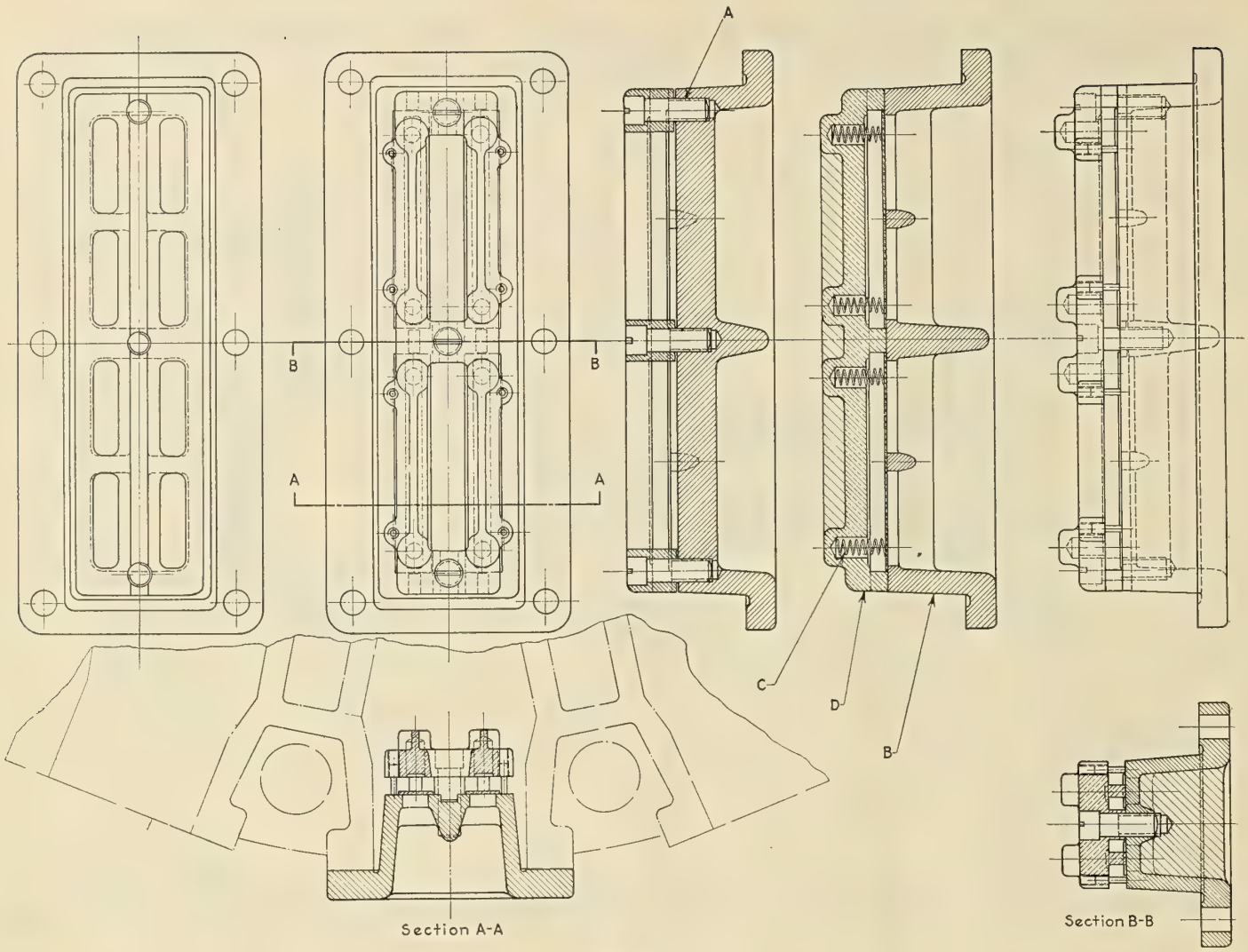


Fig. 19

of ports has no effect at first because at that time they are still obstructed by the rotary valve which controls their opening; until pressure release through the exhaust ports has taken place, the wearing surfaces of this valve are therefore subjected to the momentary cylinder pressure.

The next event is the creeping commencement of opening of the rotary valve, which begins to yield a substantial total opening only when the area of the bottom ports shows its effect. Owing to the danger of a blow-back into the scavenging receiver, the opening of the rotary valve must be retarded to a point which will give a margin of safety at any load and an availability of area corresponding to this margin must be sacrificed.

After the re-covering of the lower scavenging ports air continues to enter the cylinder through the upper ports until these also are re-covered by the piston, i. e. beyond the point of re-covering the exhaust ports, this being known as the period of super-charging. The area of the rotary valve opening is maintained at a substantial excess over that of the auxiliary (upper) ports until well after the super-charging period has ended.

The irregularity of the total net area in the neighborhood of the dead center is due to its summation of the straight port opening line and the curve of valve areas. Attention is called to the super-charging pressure P_1, which is notably higher than that shown in diagram *A*, in spite of the fact that a considerably lower scavenging air pressure can be used because the total port area is so much larger. It is to be noted, however, that the center of gravity of the area covered with vertical line shading is considerably to the right of the dead center, the interpretation of which is that a substantial part of the scavenging area is made available at a period when the piston is accelerating and when the time for utilizing the area is becoming short.

Diagram *C*

Diagram *C*, in view of what has been said, is largely self-explanatory. Attention is called to the abruptness of the valve lift curve and to the location of the center of gravity of the vertical line shading closer to the dead center than was the case with diagram *B*.

A serious disadvantage of this particular method of port scavenging is the size of the single valve required to control the entire port area and scavenging air supply. The valve lift becomes of necessity quite high and the cam must be made very steep in order to obtain as large a valve lift area as is desirable near the dead center. Considering the very appreciable weight of such a valve, the resulting kinematic forces become excessive and even where two valves are used, as has been done, these forces have proved to be too great for continuous satisfactory operation.

Diagram *C* is applicable also to valve-in-head two-cycle engines (Fig. 15) with the single modification that the dotted portion of the valve life curve would become full and the vertical line shaded area representing total scavenging opening would increase.

Diagram *D*

Diagram *D* shows scavenging area development in an engine having port scavenging controlled by automatic plate valves. Almost instantaneous development of the maximum

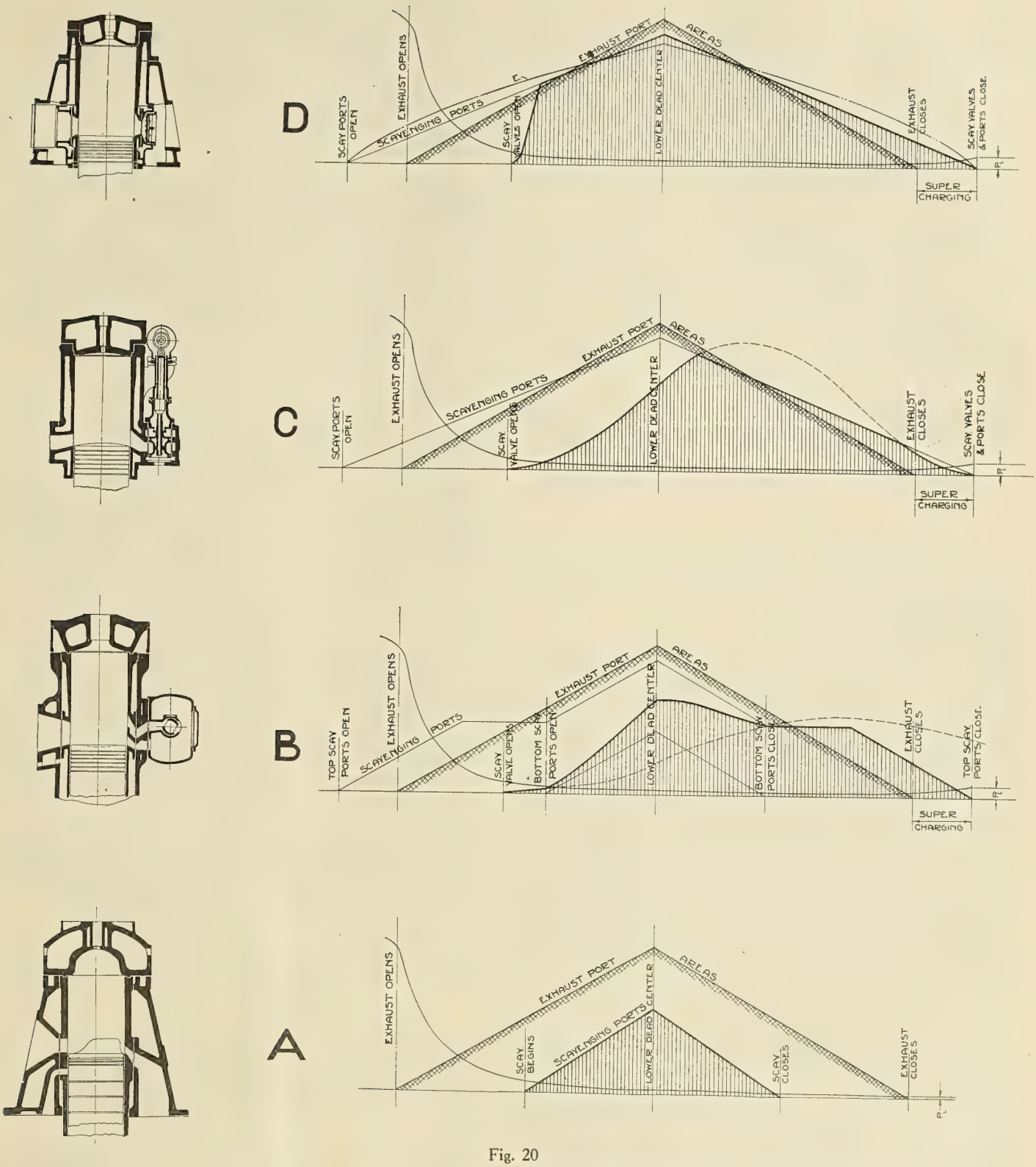


Fig. 20

possible scavenging area, its long duration over a period of slowest motion on the part of the piston and effective supercharging stand out so prominently that comment is unnecessary.

The considerably larger useful scavenging area obtainable here than with the same size ports under either of the methods illustrated at *C* or *B* make it possible to resort to lower scavenging air velocities. The necessary air pressure, and therefore the negative work, become less and the exhaust gases can be expelled at a minimum expenditure of energy. The dot-and-dash curve shows the area development that can be produced by suitably shaping the contour of the scavenging ports so as to further a still more effective supercharge.

The absence of partitions in the scavenging ports, such as are typical of the construction shown at *B*, not only adds greatly to the simplicity of the casting and manufacture but also provides the means for inducing proper radial and axial flow of the scavenging air as it enters the cylinder.

Referring to Fig. 21, *H* shows the position of the piston at the moment pressure release has taken place through the exhaust ports. Thanks to the immediate opening of the automatic valves, scavenging air rushes in full radial streams through the unobstructed ports towards the interior of the

cylinder until the momentary position of the piston causes a sudden and energetic deflection upwards, along the steeply inclined upper edge of each port. The resulting general direction of each stream is indicated by the heavy arrow; they all converge towards the cylinder center and top. As these individual streams impinge upon one another, principally within that half of the cylinder containing the scavenging ports, a further deflection towards the cylinder top occurs, which effectively displaces the exhaust gases there

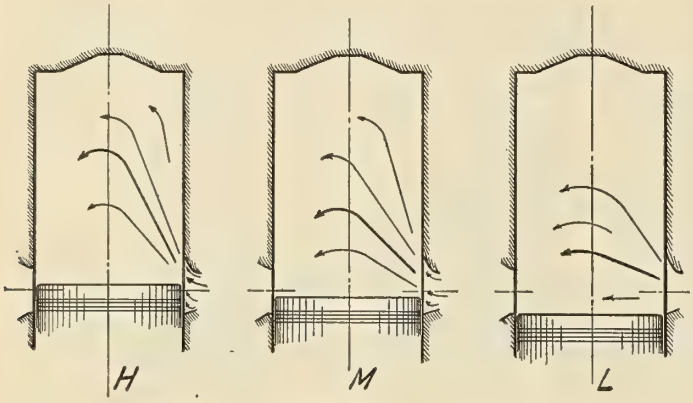


Fig. 21

and initiates their expulsion in the general direction along the opposite cylinder wall. How this process of expulsion is continued as the piston approaches the dead center position is clearly shown at *M* and *L*.

The superiority of this method of scavenging with full streams of air can now be appreciated compared to that shown at *B* where, owing to the creeping opening of the rotary valve, the streams entering the upper ports will over a large portion of the scavenging period only partly fill these ports and are therefore not very energetically deflected by the thin baffles which in these ports are necessary to take the place of the piston as a deflector. The fact that during all this time another series of air streams enters the cylinder in a different direction from the upper ones does not add to the effectiveness of scavenging. While the latter objection does not hold true with method shown at *C*, here, also, owing to the much smaller passage area uncovered by the valve than by the piston until far past the dead center, the streams of air entering the cylinder over the largest portion of the scavenging period fail to perform their function with that precision and positiveness that is so pronounced with method *D*.

Point at Which Scavenging Begins

A feature worthy of special consideration is the point at which scavenging will begin. Fig. 22 shows a light spring indicator diagram taken on a port scavenging engine of the type shown in Fig. 20-*A*. The capacity per cylinder of this particular engine is 100 brake horsepower at 225 revolutions, with a piston speed of 750 feet per minute. The full lines apply to a diagram obtained with the engine running practically at full load whereas the dashed lines apply to about 1/3 normal load.

The outstanding feature in this diagram is the momentary pressure drop of the expansion line to 3½ pounds below the atmospheric line at full load and to 1½ pounds below the atmospheric line at 1/3 load. As is well understood to-day, this pressure drop is due to inertia of the gas column in the exhaust line; it is most intense at the heaviest load, owing to the higher pressure in the engine cylinder at the moment the exhaust ports are uncovered, resulting in greater velocity of the exhaust gases out through the ports. It will be observed that at the moment the scavenging ports are uncovered the pressure in the cylinder is at either load less than that of the scavenging air, which in this particular engine was not quite 2½ pounds per square inch when the diagrams were taken. Both the full load and one-third load pressure lines intersect the scavenging air pressure line at a point to the left of the point where the scavenging ports open; scavenging could therefore begin earlier, at full load almost 30 percent earlier, if the ports were higher.

This is exactly what automatic port control makes possible and it is at these intersection points of the respective pressure lines that these control valves open. We see from this that where the load is heaviest, and the introduction into the cylinder of the greatest weight of pure air most essential, the method of scavenging shown at *D* automatically adjusts itself to this condition; scavenging not only starts earlier at heavier loads but also is initiated with greater intensity, owing to the greater drop below atmospheric pressure in the engine cylinder. This is a further reason which makes possible a reduction of the scavenging air pressure.

Automatic Port Control Simplifies Valve Gear

Automatic port control thus satisfies all essential requirements to an extent far beyond accomplishment with mechanical port control. A most beneficial advantage resulting from the use of automatic port control valves is the simplicity of the engine valve gear; the only remaining mechanically operated valve is the one required for fuel injection, which is actuated by short push rods combined with means for valve lift variation.

Reversing can be accomplished by the well-known very simple expedient of a helical sleeve, which also permits of timing variation of fuel valve to suit load and speed.

The cam shaft drive consists of the usual vertical shaft with helical gears, the satisfactory operation of which is greatly enhanced by the absence of any appreciable or abrupt loads. Each fuel pump is driven by its own eccentric from the cam shaft, establishing for every cylinder the same and unchangeable time relation between delivery stroke of the pump and point where injection into the cylinder occurs. Speed and safety governors are mounted on the vertical shaft.

The absence of any valve pockets with side outlets makes it possible to insert the cylinder head over its entire depth, except for the top flange necessary for fastening, into the

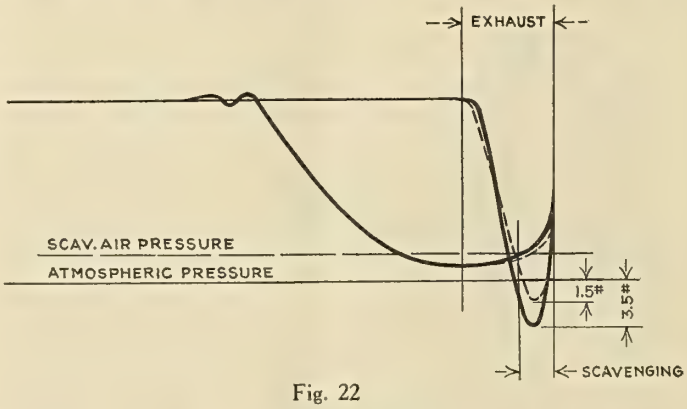


Fig. 22

cylinder bore. A comparatively light casting is the result. By this method the plain cylinder wall is continued well beyond the point where heat is imparted to it in the combustion chamber and the absence of any flanges or other material accumulations in this region of highest temperature permits of direct and intensive cooling, low mean temperatures and freedom from heat distress. The simplicity of the cylinder head, with only one small opening in the center for the fuel valve, and its favorable conical form also ensure immunity against heat influences.

(*To be concluded.*)

Balancing Engines—II

With Special Reference to Internal Combustion Engines

BY C. H. PEABODY, DR. ENG.

HAVING obtained from the discussion in the last issue a clear idea of the kind and magnitude of the accelerating forces that occur with reciprocating engines, we can take up the matter of balancing such engines. We will first consider internal combustion engines which have the greatest necessity for balancing and for which fortunately a complete balance can be the most readily made in practice.

Two Kinds of Balancing

An engine may be out of balance and may shake badly if (1) the crank shaft is not balanced and (2) if the reciprocating or accelerating forces are not balanced. These two systems of forces are entirely unlike and in any satisfactory balance they must be treated separately. A complete balance of the crank shaft is always possible; a satisfactory balance of the reciprocating parts can be had only for certain combinations. In some cases the ill effects of lack of balance of reciprocating parts may be mitigated by purposely introducing unbalanced rotating masses, and in such case the remedy brings in its own difficulties.

Balancing Locomotives

The popular idea of balancing engines is biased from the practice in America of putting counterbalance weights on the driver wheels of locomotives. Locomotives have fairly long connecting rods, six or six and a half times the crank being often used; this in part avoids extreme inequality of accelerating forces. But the pistons, crossheads, connecting rods and side bars form a heavy combination running at high speed so that large accelerating forces are developed which are applied at the outside of the frame of the engine. These forces come alternately on one side and the other of the locomotive and jerk the pilot violently from side to side, which is very unpleasant and may be dangerous. The counterbalance weights partly compensate this action and reduce the jerking; they at the same time bring in an up-and-down force that is bad for the rails and their fastenings. There is no parallel between this condition and the action of vertical engines as used on automobiles and various boats and ships.

Balancing Crank Shafts

Before taking up the process of balancing a crank shaft, let us consider the nature of the forces that occur when an unbalanced mass rotates at high speed. If the rotation is uniform, the centrifugal force developed is constant; it passes through the axis of rotation and the center of gravity of the rotating mass and moves around with it, pointing in all directions successively as it goes around the circle.

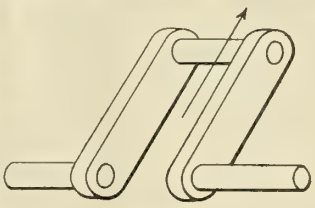


Fig. 3

The case is fairly simple for a single symmetrical crank like that represented by Fig. 3; the centrifugal force can be represented as applied at the center of gravity something less than half the length of the crank from the axis; as it goes around it pulls up against the caps of the main bearings and, if there is any looseness or elasticity in the bearings, the force will develop it. The remedy is to extend the crank webs, either the original forgings or by fastening on counterweights until the center of gravity is pulled into the axis. Whenever this can be done it is the best practice; a certain automobile was advertised as a supersix because the crank shaft being so balanced it could run fast. Even though a crank shaft, as for a six cylinder gasoline engine, has complete natural balance such counterweighting is desirable because it relieves the crank of the centrifugal force which will develop unnecessary friction if nothing worse. When such a six cylinder engine has only a few intermediate bearings and the crank shaft is slender, it may be bent enough to wear out the bearings even though made of special steel and so strong that there is no risk of breaking.

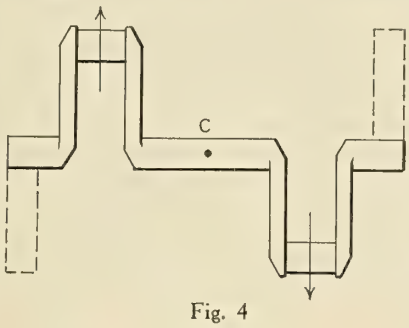


Fig. 4

In dealing with crank shafts and other rotating bodies, it is customary to speak of standing balance and running balance. This distinction can be brought out by considering the double opposed cranks of Fig. 4; if symmetrical and well made, the cranks will be in standing balance, or can readily be made so; that is, they will remain in any position when placed on horizontal knife edges. But if run at speed in bearings two centrifugal forces will be developed, equal and opposite but applied at some distance apart. They do not tend to move the shaft bodily as does the single centrifugal force of Fig. 3 but they rock the ends back and forth in the bearings and may cause a very troublesome shaking.

There are two methods of balancing the rocking couple of Fig. 4; one is to balance the cranks individually and the other is to put on outside balance weights as indicated by the dotted lines. This latter method will require less mass in the counterweights because being further apart and the centrifugal couple due to them having a longer arm the forces may be less; for example, if the distance between the counterweights is half that between the cranks then they may be half as large. But this outside balancing produces a new couple to bend the shaft. The method of outside balance may sometimes be used to advantage with two or three cranks provided the shaft is stiff enough.

There is one matter which is commonly neglected in the discussion of balancing the crank shaft, and that is the action of the connecting rod. The motion of the connecting rod is peculiar, one end moving uniformly in a circle and the other moving on a straight line; a proper mathematical discussion as given by Professor Lanza is very complicated. When the rod is short and the body slender, while the ends are heavy a fairly good result will be obtained if the two ends are weighed, supposing the off end on a knife edge; and the weights so found are assumed to be applied one at the crank pin and the other at the wrist pin; this was done in the calculation for the Jordan engine, the wrist pin end being added to the weight of the piston. In determining the counterweight for the crank the weight of the crank pin end of the connecting rod should be added to the weight of the crank pin itself; the crank will consequently appear to be over counterweighted and may not show a standing balance

on the knife edges. If it is desired to make a test on the knife edges then three weights may be prepared each equal in weight to the crank pin ends of a connecting rod, and these may be clamped to the crank pins during the test. If the connecting rods are well made and are brought to the same weight, this method will give good results.

Single Cylinder Engine

There is little that can be done by way of balancing a single cylinder engine, and if it runs fast it is likely to give trouble. The crank shaft of course may be balanced, including the crank end of the connecting rod. Small engines often have an overhung crank and then the counterweight, if applied, is to one side and a rocking couple will be developed as discussed in Fig. 4.

If such an engine shakes very badly, it may be counterweighted like a locomotive. The best result will be found by experiment; the maximum counterweight applied opposite the crank pin and at the same distance from the axis of the shaft may be equal to the combined weight of the piston, rod, crosshead and wrist pin end of the connecting rod; when there is no piston rod and crosshead the corresponding weights do not appear. If it is not convenient to apply the counterweight at the distance of the crank pin, a like result may be had by a weight placed at a convenient distance, provided that the product of the actual weight by the distince of the center of gravity from the axis of the shaft is equal to the weight first found by the length of the crank. Single crank engines often have a flywheel and the counterweight, if used, is put on that wheel. The piston and the counterweight, being out of line, develop a couple which sets up a rocking that may be annoying.

To understand the action of a counterbalanced engine consider the acceleration by aid of Table II (see May issue); the acceleration is greatest at the beginning of the down stroke, decreases rapidly to zero at about 80 degrees or 0.4 of the stroke, and then increases more slowly to the end of the stroke.

The centrifugal force acting at the center of gravity of a revolving body can be computed by the expression:

$$\frac{4\pi^2}{3{,}600} n^2 r \frac{W}{32.2},$$

where W is the weight of the revolving body, 32.2 is the acceleration due to gravity, r is the distance of the center of gravity from the axis and n is the number of revolutions per minute. Comparing this with harmonic motion; that is, the motion of a slotted crosshead, the expression will be recognized as that used for computing the accelerating force at the beginning of the stroke. This will appear natural when we consider that at the end of the stroke the slotted crosshead is brought to rest by the crank pin and that the retardation (negative acceleration) is the force the pin exerts to prevent the crosshead from flying off into space along the straight line of its motion. A body having the weight of the crosshead and piston, hung on the crank pin and revolving with it, will pull with that same force all around the circle. A counterweight for the piston and attached parts can be adjusted to produce a centrifugal force equal to the mean value of the accelerating force for the piston and attached parts at the ends of the stroke. From Table II (see May issue), it will be seen that the mean value is proportional to

$$(0.01371 + 0.00822) \div 2 = 0.0110,$$

which is the factor for harmonic motion. At the top end of the stroke this will be insufficient to start the piston; with a connecting rod four times the length of the crank, the insufficiency will be

$$(0.01371 - 0.0110) \div 0.0110 = 0.25$$

of the acceleration required to start the piston and connected parts; at the bottom of the stroke the centrifugal force will be a like amount in excess.

Without going further into detail we may say that the rotating mass will supply the equivalent of a harmonic acceleration and retardation, which will mitigate the effect of the piston and connected parts, but will not properly balance that effect. At the same time there will be introduced a transverse component from the centrifugal force which will have the same effect as a transverse slotted crosshead, and which may bring about a very annoying shaking. It will depend on the structure of the frame carrying the engine, whether it can best endure vertical or transverse shaking. A ship is likely to be stiffer vertically and may shake worse after the engine is counterbalanced; an open boat, on the contrary, may be benefited.

The single cylinder steam engine has had a wide use especially for small powers; it commonly has a flywheel, but for many purposes it runs well enough without. Small internal combustion engines frequently have one cylinder; they always have a flywheel as there is but one working stroke for each revolution when working on the two stroke cycle, and one for two revolutions on the four stroke cycle. The heavy flywheel reduces shaking as well as providing for steady running.

Free Force and Rocking Couple

Almost all discussions of balancing introduce the terms "free force" and "rocking couple." The accelerating force for a piston is called a free force, and two opposite forces like those of Fig. 4 are called a rocking couple. These terms are commonly ill defined and used obscurely; they may serve to bring out the fundamental facts of mechanics, i. e., that a force can be balanced only by an equal and opposite force acting along the same line, and further that a moment can be balanced by an equal and opposite moment.

To bring out this feature we will consider a simple case of vibration, because the shaking by an unbalanced engine is a combination of a fluctuating force with a vibrating body. Suppose that a plank is laid across two horses which are about a quarter of the length from each end. The plank will have a natural time of vibration, which a man may develop by standing in the middle and jumping up and down. By trial a man may time his motion to the natural time of vibration and by slight effort may set up violent vibrations. In like manner a single cylinder engine near the middle of the plank and run at synchronous speed will produce violent shaking.

A ship has also a natural time of oscillation with quiescent points called nodes at about one-third of the length from the ends. A single cylinder engine at or near the middle of the length will produce violent shaking, if its period synchronizes with that of the ship. This matter is not simple and, fortunately, we need not go far in it because we are more interested in balancing engines, and if the balance is fairly satisfactory we need not trouble about the oscillation of the ship.

Returning to our plank on its horses, we may consider that a man may set up an oscillation by standing astride one of the horses and throwing his weight first on one side and then on the other; a two cylinder engine, with opposite cranks, run at synchronizing speed will do the same thing to a ship if placed at or near a node. If only the case were as simple as the preliminary statement, we could announce the policy, keep free forces from the middle of the ship and rocking couples away from the nodes; but engines must go where they can and a ship will develop amazing oscillations, due either to free forces or rocking couple.

Two Cylinder Engines

Two cylinder engines are usually of types, (1) with cranks opposite like Fig. 4, or (2) with cranks at right angles.

The first type, with opposite cranks, is commonly used for internal combustion engines, and the second type for steam engines. The first type has a partial balance of the accelerating forces of the pistons; with a connecting rod four times the crank, the piston at the top beginning the down stroke has 1.7 times the acceleration of the other, leaving the 0.7 to set up a free force. As compared with a single cylinder engine of the same power, this two crank engine has a considerable advantage, even though the two accelerating forces, one up and one down, may set up a rocking of the engine. Such engines being usually small and cheap are likely to be unbalanced.

The two crank steam engine is habitually used for all types of reversing engines, on locomotives, hoisting engines and to a considerable extent on small steamers. Even without a flywheel it gives a fairly even rotation. The balancing of locomotives has already been mentioned; other engines of the type are commonly unbalanced. Two cylinder marine engines with direct connection to the propeller do not usually run very fast and the shaking that takes place is taken as inevitable, especially as it cannot well be remedied. Counterweights on the crank shaft are unpopular as they interfere with ready access to the shaft bearings. This so-called quarter-crank engine has both free forces and rocking couples.

A very good balance has been obtained for two cylinder steam engines for driving blowers. The middle bearing of the shaft was suppressed and the cranks were brought near together, so that the inner crank webs coalesced. The engine, which was usually horizontal, had one cylinder on one side

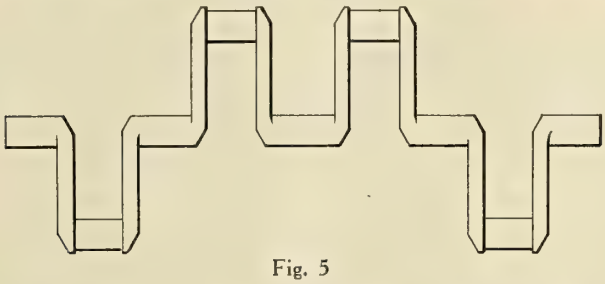


Fig. 5

of the crank shaft and the other cylinder on the opposite side. The two pistons consequently started at the same time to move toward the shaft and both had then their maximum accelerating force; the pistons had the same weight and the accelerating forces were completely balanced. Since the cranks were close together, the rocking couples were small and gave little trouble. In the early history of automobiles this type of engine with cylinders on opposite sides of the crank found some favor; it will be remembered that some automobiles had but one cylinder, even as some motor cycles have to this day.

Three Cylinder Engines

The three cylinder engine with three cranks evenly spaced around the circle requires careful consideration both from its deservedly high reputation with steam engineers and because a discussion of this type leads to an arrangement with six cylinders which gives a complete balance, an arrangement most commonly used for automobiles.

Except for very large powers the three cylinder triple steam marine engine has been found very satisfactory, so much so that it is the commonly accepted type. A fairly satisfactory expansion of the steam and a good distribution of power can be had and the engine has a high reputation for steadiness and smooth running. Usually the pistons have varying weights, depending on their diameters, and in such case the free forces are not in balance; there are also decided rocking moments.

If the cranks are evenly spaced and if the three pistons are made to have the same weight, there will be no free force. To demonstrate this important point we may turn to Table II (see May issue), and select the proper acceleration factor at intervals of 120 degrees; thus for the ratio of 4 for the connecting rod and crank we have:

Angles	Accelerating Factor	Accelerating Force
0	0.01371	$0.01371 \frac{W}{g} n^2 r$
120	0.00685	$-0.00685 \frac{W}{g} n^2 r$
240	0.00685	$-0.00685 \frac{W}{g} n^2 r$
		Sum zero

The force at 120 degrees is a retardation and therefore is negative and at 240 degrees the acceleration acts upwards and is also negative. At any other angle the same result is found; thus at 40 degrees we have:

Angles	Accelerating Factor	Accelerating Force
40	0.00893	$0.01091 \frac{W}{g} n^2 r$
160	0.00818	$-0.00818 \frac{W}{g} n^2 r$
280	0.00075	$-0.00075 \frac{W}{g} n^2 r$
		Sum zero

A stray unit in the last decimal place is, of course, due to the unavoidable inaccuracy of that place of figures.

Using this property of the three crank engines one of the best American builders of torpedo boats has found good results by simply giving the same weight to all the pistons. The rocking moments are taken care of by tying the tops of the cylinders fore and aft to the framing of the ship.

Four Cylinder Engines

The accepted arrangement of cranks for the less expensive automobiles is given by Fig. 5, which will be recognized as the two crank arrangement of Fig. 4 doubled and reversed. The two pistons attached to the middle cranks of Fig. 5 are at the tops of their strokes and their accelerating forces are 1.7 times those of the pistons attached to the outer cranks, if the connecting rod is four times as long as the crank. The accelerating forces are unbalanced to the same extent as for the two-crank arrangement of Fig. 4; but there is no rocking moment provided that the crank shaft is symmetrical fore and aft. The automobile engine habitually runs on the four stroke cycle and consequently this arrangement provides an explosion for each half revolution; the four crank engine of this type requires a flywheel like the single cylinder steam engine and it gives nearly as good a rotative effect. Since this engine, like all automobile engines, is unclutched and started without a load, the four crank arrangement with a flywheel works fairly well in all kinds of service.

Gasoline engines used for propulsion of small boats, yachts, etc., run on the four stroke cycle. They may have a single cylinder, two cylinders or four cylinders; some high power boats have a large number of cylinders. The two and four cylinder types have the cranks like Fig. 4 or Fig. 5. Heavy oil engines, whether Diesel engines or hot bulb engines, may work on the four stroke cycle or on the two stroke cycle with scavenging arrangements. In either case a two cylinder engine will have opposite cranks like Fig. 3; the two stroke cycle with two cranks is nearly equivalent to a single cylinder steam engine in steadiness of running.

The heavy oil engine with four cylinders working on the

four stroke cycle will have opposite cranks like Fig. 5; it is free from rocking moments and not very badly out of balance. Should such an engine work on the two stroke cycle, the cranks may be set quartering; the best arrangement is to have the first and second cranks opposite; the second and third cranks are also opposite, but quartering from the first pair of cranks. This arrangement gives nearly as steady running as a quarter crank two cylinder steam engine. The engine has both free force and rocking moments, there being no satisfactory way of balancing the pistons. The lack of balance may not be very troublesome, especially on low powered ships like freighters.

A great deal of ingenuity has been spent on attempts to balance four crank steam engines; some think that there has been a waste of ingenuity. In the first place, it may be premised that the reasons for going to four cranks are (1) to provide for quadruple expansion or (2) to divide the low pressure cylinder when it becomes of inconvenient size. Quadruple engines were introduced more than thirty-five years ago, but have not found general acceptance, the gain in economy being in part offset by the complication and the difficulties introduced by high pressure and temperature. The cranks are usually spaced uniformly around the circle because it is convenient to have the cylinders arranged in order of their size and pressure, and because it is very convenient to be able to maneuver the engine with steam bypassed to the second intermediate and the low pressure cylinder. Another arrangement is to have the low pressure and second intermediate cranks opposite, and the other two cranks opposite, but at a quarter circle from the first pair. In any case the pistons commonly are of unequal weight and the engine has unbalanced free forces and rocking couples; the lack of balance is not very troublesome.

When a triple engine has two low pressure cylinders they each develop one-sixth of the power of the engine; the high and intermediate cylinders each develop one-third of the power. This unequal distribution of power makes the engine inferior, in this respect, to the regular three crank triple marine engine. The natural arrangement of cylinders is to place the high pressure cylinder forward and the two low pressure cylinders aft. In such case the two low pressure cranks may be opposite and the two other cranks are also opposite, but quartering from the first pair; the engine may be maneuvered by the intermediate and low pressure cranks.

Sometimes a triple four cylinder engine has the low pressure cylinders placed at the ends of the engine, one forward and the other aft; the intermediate and high pressure cylinders are placed in the middle. The steam lead is fairly simple, being from the high cylinder to the intermediate and the aft low pressure cylinder in regular order; the lead from the intermediate past the high pressure cylinder to the forward low pressure cylinder is rather long. The engine can be maneuvered from the intermediate and low pressure cylinders. The cranks may be set in the following order, forward low pressure crank at 0 degrees, after low pressure crank at 90 degrees, high pressure crank at about 150 degrees, and intermediate crank at about 250 degrees. The two forward cranks are 30 degrees from being opposite and the two after cranks are 20 degrees off. The low pressure piston rods, crossheads and connecting rods are lighter than those for the other two cylinders; the pistons are somewhat larger and heavier than the intermediate piston; though not commonly done, the weights of all reciprocating parts may be made the same for all cylinders.

By a somewhat complicated system of graphical construction an investigation can be made to develop the free forces and rocking moments all round the circle, taking account also of the valves which are heavy and have an appreciable effect. After a thorough study has been made efforts may be set on foot for improvements by changing weights of the pistons and the crank angles. With care and skill good results may be had by experts. A special method of balancing is patented under the name of the Yarrow-Schlick-Tweedy system, which follows this same line, but the details are unrevealed. There is much difference of opinion concerning the value of the method here sketched out, and of the patented method named. In some cases satisfactory results are had and in others not. Probably the success or failure may be due to the relative conditions of hull and engine. Theoretically a complete balance of a four cylinder engine is impossible.

The Six Cylinder Engine

It has been shown that a three cylinder engine with cranks spaced equally and with all pistons having the same weight, has complete balance of free forces; there remain rocking couples. Now if we take two such three crank engines and place them in line with the two cranks together at the middle of the combination we will have an arrangement that is free from free forces and rocking moments; or perhaps we should say, that, if the base of the engine is stiff enough, all the dynamic effects will be self contained.

This six cylinder arrangement is standard for all high class automobiles and in practice leaves little to be desired. The rotative effect is not so good as for a quarter crank steam engine, but the engine has a flywheel and is started unclutched, so that there is small reason for complaint.

The desirable type of engine for marine propulsion whether with Diesel engines or hot bulb engines is this six crank type, both for two stroke cycles or four stroke cycles.

Multiple Cylinder Engines

In the attempt to get more power or greater smoothness of action both for automobiles or for aeroplanes, various combinations having more than six cylinders have been used. Usually such engines have a *V*-frame, with the cylinders set at an agle so that two connecting rods may act on one crank. There are two favored types, one having eight cylinders and the other twelve; that is, we may have twin fours or twin sixes. The twin six is completely balanced because each element is so individually. The twin four is not completely balanced; the engine runs very smoothly and has the credit of taking hard and irregular roads better; it is shorter than a six cylinder engine of the same power. Except for the multiplicity of cylinders and appurtenances the twin six appears to be ideal for automobiles.

But a summation of all conditions leads to the conclusion that for internal combustion engines the six crank engine is the most desirable for land and sea.

Allowing for Contraction While Making Large Rudder Frame Welds

THE problem of allowing for cooling contraction after pouring thermit welds was handled in an interesting manner during the recent repair of the eleven-ton rudder frame of the steamship *New Rochelle* of the United States Mail Steamship Company, which was cracked in three separate places, the fractures extending from about 4 inches to 6 inches into the frame.

Before making these repairs the rivets which fastened the rudder plate to the rudder frame were first removed in order to prevent the plate from buckling due to contraction when the weld had cooled. The fractures extended only part way through the chunky sections of the rudder frame. Consequently during preheating care had to be taken to preheat thoroughly the adjacent unfractured parts in order to offset the cooling strains later. The welds required a total of about 900 pounds of thermit.

The repair, made by the Robins Dry Dock and Repair Company, Brooklyn, N. Y., cost only $1,500 and required only about 4 days.

Approximate Stability Formulae

BY HEINRICH SCHULTZ, DR. ING.

Almost all usual methods of calculating stability by planimeter or integrator are rather complicated, and the time required is often out of proportion to the results obtained. What the naval architect needs is a short and simple method which will give him the angle of maximum stability, the maximum righting lever, the angle of vanishing stability, or the entire curve of righting levers with sufficient accuracy for practical purposes. Such a method has been developed in the author's treatise in "Shiffbau," December 15, 22 and 29, 1920, and follows in condensed form.

THE method of calculating stability outlined in the following is purely analytical and the formulae are based on the well-known values of BM and GM of initial stability and the shift of the CB from the upright position to 90 degrees inclination, expressed in rectangular co-ordinates n and p. The latter two values are easily obtained from the body plan, or they can be calculated in sufficient approximation by empirical formulae. When the fundamental data, viz., BM, GM, n and p, have been obtained, the curve of stability can be obtained in a few minutes by means of a slide rule.

The symbols used in the formulae are as follows:

B_0 = beam of vessel.
H = depth of vessel.
D = draft of vessel.
b_0 = function of beam.
δ = block coefficient.
a = coefficient of fineness of $L.W.L.$
$L.W.L.$ = load waterline.
f = freeboard.
f' = virtual freeboard.
K = keel point.
B = center of buoyancy in upright position.
B_{90} = center of buoyancy in 90-degree position.
B' = projection of B_{90} on centerline of vessel.
M = transverse metacenter in upright position.
G = center of gravity of vessel.
$n = BB'$.
$p = B_{90}B'$.
$q = p - n$.
ϕ = angle of inclination.
ϕ_m = angle of maximum stability.
ϕ_k = angle of vanishing stability.
$GZ\phi$ = lever of statical stability.
GZ_a = arithmetic average of all ordinates GZ.
$B'Z\phi$ = distance from B' to line of action of righting force.
$KZ\phi$ = distance from K to line of action of righting force.
$h\phi$ = lever of dynamical stability.
V = volume of displacement.
v = volume of one-half of vessel below $L.W.L. = \frac{1}{2}V$.
v' = volume of one-half of vessel above $L.W.L.$
z = $C.G.$ of v below $L.W.L.$
z' = $C.G.$ of v' above $L.W.L.$
s = $C.G.$ of v from $C.L.$
s' = $C.G.$ of v' from $C.L.$
e = $C.G.$ of middle line plane from $L.W.L.$
a = thickness of correcting layer $= (v - v') \div$ area of middle line plane.
A_a = positive area under statical stability curve.
A_b = negative area under statical stability curve.

Calculation of Angles of Maximum and Vanishing Stability and of Maximum Lever of Statical Stability

The angle of maximum stability, Φ_m, can be derived from the formula:

$$(1) \quad \sin^2 \phi_m = \tfrac{1}{2} \frac{GM + n}{BM}.$$

The range of stability or angle of vanishing stability, ϕ_k, can be derived from the following formulae:

$$(2) \quad \sin^2 \phi_k = \frac{GM + n}{BM} \text{ for angles up to 90 degrees}$$

$$(3) \quad = 90 + 120 \frac{GZ_{90}}{BM} \text{ for angles up to 90 degrees and larger.}$$

The maximum lever of statical stability, GZ_{max}, can be obtained as follows:

$$(4) \quad GZ_{max} = p - n + GZ_{90} \sin \phi_m$$
$$= p - n + GZ_{90} \times 0.71 \sqrt{\frac{GM + n}{BM}}.$$

Formulae (1), (2) and (4) include a certain margin of safety, whereas formula (3) gives very close results.

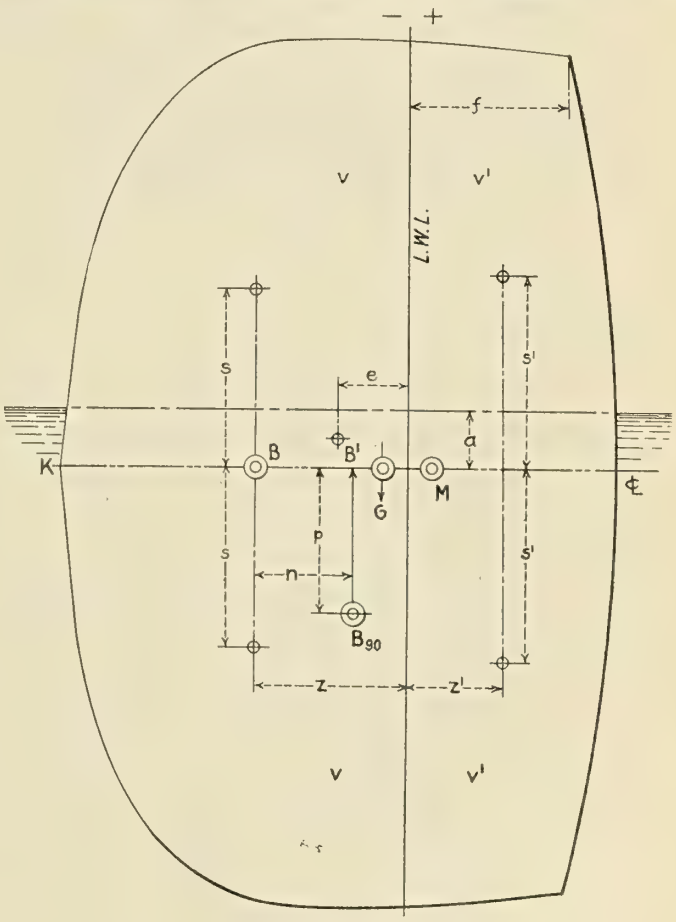


Fig. 1

Calculation of Righting Levers

The righting lever at any angle equals:

$GZ\phi = B'Z\phi \pm B'G \sin \phi.$
$B'G \sin \phi = GZ_{90} \sin \phi = (n - BG) \sin \phi.$
$GZ\phi = B'Z\phi + (n - BG) \sin \phi.$

The values of $B'Z$ can be obtained from the following formulae:

(5) When $\dfrac{BM - n}{q}$ is between 1 and 2

$B'Z_{15} = 0.264\ (BM - n)$
$B'Z_{30} = 0.9q$
$B'Z_{45} = q$
$B'Z_{60} = q \sin 60° = 0.866q$
$B'Z_{75} = \frac{1}{2}q$
$B'Z_{90} = 0.$

COMPARISON OF STABILITY VALUES OBTAINED BY EXACT CALCULATIONS (R) WITH THOSE FROM FORMULAE 1 TO 6

No.	Type	Displ. Tons	GM	BM	BG	p	n	u − d = b	$GZ_{90} = u - BG$	Angle of Max. Stability R	Angle of Max. Stability Form 1	GZ Max. R	GZ Max. Form 4	Range of Stability R	Range of Stability Form 2	Range of Stability Form 3	Values of GZ 15° R	15° F 5 & 6	30° Form. 6	30° R	30° 5	45° 6	45° R	45° 5	60° 6	60° R	60° 5	75° 6	75° R	75° 5	BM-n / p-n
1	Sailing Vessel	3,000	3.28	8.43	5.15	6.82	4.50	2.32	−0.65	38°	42°	2.04	1.87	81°	76.5°	80.7°	0.92	0.85	1.77	1.84	1.77	2.00	1.97	1.87	1.44	1.35	1.44	0.49	0.39	0.52	1.70
2	"	4,560	1.94	7.48	5.54	5.74	3.68	2.06	−1.86	39°	37°	0.89	0.95	59°	60°	60°	0.56	0.53	0.98	0.89	0.85	0.85	0.66	0.75	+0.03	−0.13	+3.16	0.850	0.800	0.853	1.84
3	"	9,000	1.67	9.81	8.13	7.64	4.99	2.65	−3.14	26°	34°	0.95	1.28	55.5°	55.5°	51.5°	0.53	0.43	0.89	0.85	0.82	0.59	0.49	−0.49	−0.52	−0.43	−1.80	−1.80	−1.80	1.82
4	"	10,500	1.74	9.35	7.61	6.23	2.17	1.38	−1.38	37°	40°	1.38	2.40	67°	—	72.3°	0.69	0.46	1.21	1.31	1.08	1.38	1.25	1.18	0.56	0.69	0.46	−0.16	−0.33	−0.29	1.52
5	Yacht "Jullanar"	153	3.28	4.30	1.02	3.84	3.31	0.53	+1.29	70°	60°	2.52	2.52	—	—	—	0.85	0.85	1.77	1.57	1.61	2.23	2.20	2.20	2.53	2.53	2.46	2.30	2.53	2.56	1.88
6	Cargo Steamer	1,940	1.48	6.40	4.92	7.05	5.90	1.15	+0.98	55°	48.5°	2.14	1.90	—	—	—	0.49	0.39	1.25	1.25	—	2.00	2.07	1.84	2.17	2.13	(1.84)	1.77	1.58	1.54	0.43
7	Cargo & Pass. Steamer	13,000	0.66	9.25	8.60	9.81	7.90	1.91	−0.70	48°	42°	1.77	1.44	74°	—	81.1°	0.20	0.16	0.95	0.95	—	1.71	1.67	1.44	1.51	1.51	(1.08)	0.62	0.56	(0.26)	0.71
8	" " "	18,000	0.95	14.18	13.22	15.74	14.43	1.31	+1.21	50°	45°	3.25	2.53	—	—	85.25°	0.36	0.39	1.44	1.41	—	2.85	3.08	2.53	2.95	4.17	(2.20)	1.84	1.97	(1.28)	0.11
9	" " "	50,000	1.97	25.70	23.74	27.14	22.72	4.42	+1.02	55°	43.5°	3.71	3.41	85°	78°	76°	0.62	0.75	2.49	2.33	—	4.23	4.17	3.68	(2.92)	4.17	(2.92)	1.90	1.97	(1.18)	0.68
10	Cargo Steamer	440	3.02	4.78	1.77	2.53	1.22	1.31	−0.55	38°	41°	0.92	0.95	75°	70°	—	0.69	0.79	1.12	0.92	0.92	0.92	0.85	0.92	0.46	0.46	0.66	−0.03	0.00	+0.10	0.23
11	Cable Steamer	3,600	1.97	6.99	5.02	7.05	5.97	1.08	+0.95	60°	48.5°	1.97	1.81	—	—	—	0.62	0.53	1.35	1.31	1.44	1.90	1.80	1.77	2.00	1.77	1.87	1.61	1.51	1.51	0.94
12	Steam Yacht	540	1.21	4.33	3.12	4.07	3.15	0.92	+0.03	52.5°	45°	1.02	0.95	—	—	—	0.43	0.33	0.76	0.79	0.82	1.02	1.02	0.95	0.86	0.98	0.82	0.56	0.62	0.49	1.30
13	Steam Trawler	390	2.33	5.25	2.92	4.23	3.41	0.82	+0.49	40°	47°	1.15	1.18	—	—	—	0.75	0.59	1.21	1.15	0.98	1.28	1.21	0.92	0.92	0.98	1.15	0.82	0.82	0.89	2.24
14	Canal Steamer	500	2.23	6.13	3.90	4.26	2.56	1.70	−1.34	38°	38.5°	1.08	0.89	62°	—	63.7°	0.69	0.59	1.05	1.05	0.89	0.75	0.89	0.89	0.20	0.20	0.36	0.79	0.79	−0.46	1.96
15	Fire Ship	300	1.51	4.40	2.89	4.00	3.38	0.62	+0.49	45°	47°	1.05	0.98	—	—	—	0.39	0.39	0.85	0.89	0.79	1.05	0.98	1.05	0.92	0.92	0.95	0.79	0.79	0.63	1.10
16	Surveying Steamer	650	1.94	7.97	6.03	7.45	6.03	1.42	+	45°	49°	1.41	1.41	—	—	—	0.52	0.52	1.25	1.21	1.28	1.57	1.54	1.44	1.31	1.31	1.21	1.25	1.25	0.72	1.37
17	Battleship	12,800	3.51	17.03	13.50	13.50	8.92	4.58	−4.58	35°	37°	2.04	1.84	64°	58.5°	57.5°	0.92	0.98	1.87	2.00	1.84	1.61	1.54	1.35	+0.03	+0.03	0.00	−2.26	−2.26	−2.29	1.77
18	"	24,000	5.15	21.68	16.53	16.21	9.90	6.31	−6.63	32°	36°	1.77	1.41	58.5°	56°	53.5°	1.38	1.12	2.59	2.69	2.36	1.94	1.80	−0.52	−0.36	−0.36	−0.29	−3.54	−3.45	−3.48	1.87
19	"	23,800	4.20	21.05	16.88	16.27	10.04	6.23	−6.84	32°	35°	2.40	2.30	56°	55°	51°	1.54	1.12	2.36	2.36	2.20	1.74	1.64	1.41	−0.66	−0.69	−0.49	−3.74	−3.84	−3.71	1.77
20	Battle Cruiser	24,000	8.53	22.98	14.44	15.75	9.25	6.50	−5.19	34°	39°	3.54	3.35	63°	61.5°	63°	2.17	2.26	2.76	2.76	3.25	3.08	3.02	2.82	0.66	0.62	1.15	−3.25	−3.36	−1.94	2.10
21	"	26,000	9.51	23.12	13.62	15.80	8.99	6.81	−4.63	35°	39°	4.46	3.90	66.5°	63.5°	67°	2.43	2.53	4.33	4.46	3.84	3.77	3.77	3.58	1.41	1.21	1.10	−2.17	−1.54	−1.24	2.10
22	Cruiser	9,800	2.40	12.67	10.27	11.78	10.10	1.68	−0.17	40°	44°	1.54	1.57	87°	83°	88.4°	0.85	(0.62)	1.67	1.41	1.41	1.77	1.54	1.80	1.05	1.25	1.30	0.65	0.72	0.69	1.53
23	"	7,000	3.31	8.92	5.61	9.58	7.67	1.91	+2.06	55°	52°	2.04	3.54	—	—	—	0.72	(0.89)	2.20	2.23	2.76	3.61	3.51	3.05	3.97	3.81	3.71	3.81	3.31	3.21	0.66
24	"	6,500	3.61	11.55	7.94	9.67	6.85	2.82	−1.09	40°	42°	2.26	2.10	76°	72°	78.8°	1.05	0.95	2.00	2.17	2.00	2.30	2.26	1.51	1.64	1.51	1.51	0.36	0.13	0.03	2.10
25	"	5,500	3.61	11.32	7.71	11.48	9.84	1.64	−2.13	55°	50°	2.33	3.28	—	—	—	1.05	0.95	2.33	2.36	2.53	3.38	3.41	3.15	3.45	3.48	3.25	3.12	3.02	2.95	0.90
26	"	4,900	3.61	10.82	7.21	10.57	8.82	1.75	+1.61	55°	49°	3.05	2.92	—	—	—	1.15	0.95	2.30	2.23	2.36	2.76	2.95	2.85	3.05	3.05	2.89	2.56	2.46	2.46	1.15
27	"	3,100	1.94	7.74	5.80	7.28	6.63	0.65	+0.83	45°	47°	1.18	1.25	—	—	—	0.59	0.53	1.51	1.12	1.18	1.35	1.18	1.25	0.92	1.18	1.27	1.08	1.05	1.15	1.70
28	Gunboat	1,700	2.30	8.33	6.03	7.74	6.69	1.05	−0.66	45°	47°	1.54	1.54	—	—	—	0.72	0.62	1.48	1.38	1.28	1.64	1.51	1.48	1.28	1.28	1.48	1.18	1.05	1.18	1.56
29	"	1,100	1.74	8.10	6.36	7.48	6.46	1.02	+0.10	52°	45°	1.15	1.08	—	—	—	0.49	0.46	1.15	0.85	0.95	1.21	1.08	1.03	1.02	1.02	0.95	0.62	0.59	0.59	1.61
30	Torpedo Boat	530	2.92	7.25	4.33	5.74	4.46	1.28	−0.13	45°	45°	1.48	1.38	—	—	—	0.72	0.79	1.51	1.35	1.25	1.54	1.48	1.38	0.98	1.21	1.25	0.69	0.62	0.82	2.18
31	"	640	3.58	7.70	4.13	6.10	4.66	1.44	+0.53	45°	47°	1.97	1.84	—	—	—	0.95	0.95	1.77	1.67	1.54	1.97	1.94	1.80	1.48	1.48	1.71	1.15	1.05	1.25	2.11
32	Destroyer	800	3.38	7.31	3.94	5.67	4.23	1.44	+0.29	40°	45°	1.80	1.64	—	—	—	0.85	1.18	2.40	2.07	2.03	2.69	2.62	2.49	1.35	2.36	2.59	0.95	0.82	2.36	2.19
33	"	1,300	4.46	9.61	5.15	8.13	6.85	1.28	+1.70	50°	50°	2.70	2.59	—	—	—	1.15	0.79	1.35	1.44	1.51	1.64	1.80	1.74	1.44	1.67	1.44	1.15	1.18	1.15	1.74
34	"	1,300	2.95	9.01	6.07	7.94	6.50	1.44	+0.43	48°	46°	1.80	1.74	—	—	81.4°	0.79	0.36	0.45	0.41	0.42	0.49	0.39	0.43	0.23	0.26	0.33	0.03	0.07	0.07	2.61
35	Sea-going Submarine	1,060	1.31	3.22	1.90	2.26	1.67	0.59	−0.23	32°	42°	0.43	0.43	78°	75°	—	0.36	0.36													

Note: All dimensions given are in feet unless otherwise marked.

(6) For any value of $\dfrac{BM - n}{q}$

$$B'Z_{15} = 0.264\ (BM - n)$$
$$B'Z_{30} = 1.766q - B'Z_{60}$$
$$B'Z_{45} = 0.48q\left(1 + 0.735\,\frac{p+n}{p}\right)$$
$$B'Z_{60} = 0.5\,p - 0.583\left(\frac{n}{p}\right)^3 BM$$
$$B'Z_{75} = 0.259\,p - 0.268\left(\frac{n}{p}\right)^3 BM$$
$$B'Z_{90} = 0.$$

Using formula (5), we get:

$$GZ_{60} = q \sin 60^\circ + GZ_{90} \sin 60^\circ$$
$$= \sin 60^\circ\ (p - n + n - BG)$$
$$= 0.866\ (p - BG)$$
$$GZ_{75} = \tfrac{1}{2}q + GZ_{90} \sin 75^\circ$$
$$= \frac{p-n}{2} + 0.966\ (n - BG)$$
$$= \frac{p+n}{2} - BG \text{ (approx.)}$$

From the foregoing the following approximations can be deduced:

(7) When $BG = n$, the range of stability is 90 degrees.

(8) When $BG = \dfrac{p+n}{2}$, the range of stability is at least 75 degrees.

(9) When $BG = p$, the range of stability is at least 60 degrees.

The above formulae hold good for all types of sea-going vessels, including battleships and submarines. The accompanying table shows a comparison of the results obtained by the above formulae and by exact calculations for 35 vessels.

CHECK ON FORMULAE (5) AND (6)

Formulae (5) and (6) may be checked as follows:

$$h_{90} = p - BG$$
$$h_{90} = \int_0^{\pi/2} GZ\,d\phi = \frac{A_a - A_b}{\text{base line}} \times \frac{\pi}{2} \quad \text{(see Fig. 2)}$$
$$= GZ_a \times \frac{\pi}{2}.$$

Then

$$p - BG = GZ_a \times \frac{\pi}{2},$$

provided p is obtained by exact calculation. GZ_a may be calculated by Simpson's rule.

CALCULATION OF n AND p

The importance of the n and p values for calculating stability makes it desirable to determine them quickly and, if possible, analytically. The following formulae have been found to give very good results:

(10) $$n = \frac{1}{V}\left[(vz + v'z') \pm e\,(v - v')\right] \text{ (modified Attwood's rule).}$$

For an ideal wall-sided vessel without sheer or camber, formula (10) becomes:

(11) $$n = \frac{D}{4}\left(\frac{f}{D}\left[\frac{1 + \delta/a}{\delta/a}\right] - \tfrac{2}{3}\,[1 - \delta/a]\right)$$

The expression on the right-hand side of formula (11) shrinks to $\dfrac{f}{2}$ when $\delta/a = 1$, and also for any value of δ/a, provided $\dfrac{f}{D} = \tfrac{2}{3}\,\delta/a$.

When $\delta/\alpha > 0.9$, n becomes approximately $\dfrac{f}{2}$.

When $\dfrac{f}{D}$ is somewhat greater or less than $\frac{2}{3}\,\delta/\alpha$, n differs but slightly from $\dfrac{f}{2}$.

For flush deck vessels with sheer and camber the virtual freeboard, f', is substituted for f.

$f' = 2v' \div$ area of water plane at a height of $\dfrac{f}{2}$ above *L.W.L.*

For practical purposes the formula for n may then be written:

$$(12)\quad n = \frac{f'}{2}.$$

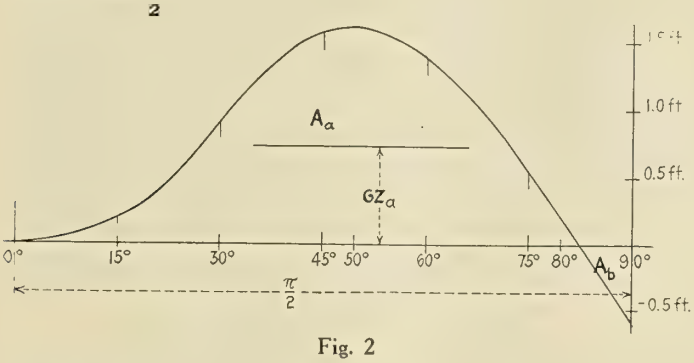


Fig. 2

The following table shows a comparison of the results obtained by exact calculation, from formula (12) and from formula (11a) [formula (11) with f' substituted for f]:

Type	f' Feet	D Feet	δ/α	f'/D $\frac{2}{3}\delta/\alpha$	n (11a)	n (12)	n Exact Calc.
Cargo steamer...	8.33	12.98	0.92	1.05	4.17	4.17	4.10
Cargo steamer...	12.53	25.69	0.90	0.81	6.20	6.26	6.30
Sailing ship.....	9.15	16.40	0.79	1.06	4.59	4.57	4.50
Sailing ship.....	6.88	22.32	0.83	0.56	3.15	3.44	3.22
Pilot steamer....	4.92	10.32	0.66	1.09	2.52	2.46	2.56

p can be calculated quite accurately by Moseley's rule, modified:

$$(13)\quad p = \frac{1}{V}\left[(vs + v's) - \frac{a}{2}(v - v')\right]$$

in which

$$s^1 = \frac{B_o}{2}\,\frac{a}{1+a},\ \text{(approximate)}$$

$$s = \frac{b_o}{3}\,[\tfrac{1}{2} + \delta/\alpha\,(1.10 - 0.10\alpha)],$$

$$b_o = \frac{B_o}{2}\,\frac{3\alpha}{2\alpha + 1}.$$

p can also be calculated approximately with relation to n, as follows:

$$(14)\quad p = \frac{b_o}{4}\,\frac{8n + \dfrac{D}{3}(1 - \delta/\alpha)}{D + 2n}.$$

The expression on the right-hand side of the formula is always somewhat greater than $\dfrac{2nb_o}{D + 2n}$, and for full vessels where $\delta/\alpha > 0.90$, formula (14) becomes very nearly:

$$(15)\quad p = \frac{2\,nb_o}{D + 2n}.$$

Formula (15) gives very good results.

EXAMPLE

Cargo steamer, well-deck type, with usual sheer:
448 feet by 54 feet by 25.7 feet draft.
Displacement = 13,500 tons.
$GM = 0.655$ feet; $BM = 9.240$ feet; $BG = 8.585$ feet.
$\delta = 0.761$; $\alpha = 0.844$; $\delta/\alpha = 0.902$.

The volume $2v'$ was calculated as 339,800 cubic feet, and the area of the water plane at a height of $\dfrac{f}{2}$ above the *L.W.L.* was 21,300 square feet. From formula (12):

$$n = \frac{f'}{2} = \tfrac{1}{2}\,\frac{339{,}800}{21{,}300} = 7.97 \text{ feet.}$$

An exact moment calculation of the body plan gives $n = 7.90$ feet.

From formula (15):

$$p = \frac{2\,nb_o}{D + 2n} = \frac{2 \times 7.97}{25.7 + 15.94} \times \frac{54}{2} \times \frac{2.532}{2.688} = 9.75 \text{ feet.}$$

$$q = p - n = 9.75 - 7.97 = 1.78 \text{ feet.}$$

$$\frac{BM - n}{q} = \frac{9.24 - 7.97}{1.78} = 0.71.$$

Since $\dfrac{BM - n}{q}$ is less than 1, formula (6) must be used for calculating righting levers.

$$GZ_{90} = B'G = n - BG$$
$$= 7.97 - 8.585 = -0.615 \text{ feet.}$$

$$GZ\phi = [B'Z\phi] + [B'G \sin \phi].$$

$$GZ_{15} = [0.264\,(9.24 - 7.97)] + [-0.615 \times 0.259] = 0.176 \text{ feet.}$$

$$GZ_{30} = [1.766 \times 1.78 - 1.925] + [-0.615 \times 0.500] = 0.916 \text{ feet.}$$

$$GZ_{45} = \left[0.48 \times 1.78\left(1 + 0.735\,\frac{9.75 + 7.97}{9.75}\right)\right] + [-0.615 \times 0.707] = 1.560 \text{ feet.}$$

$$GZ_{60} = \left[0.5 \times 9.75 - 0.583\left(\frac{7.97}{9.75}\right)^2 9.24\right] + [-0.615 \times 0.866] = 1.392 \text{ feet.}$$

$$GZ_{75} = \left[0.259 \times 9.75 - 0.268\left(\frac{7.97}{9.75}\right)^3 9.24\right] + [-0.615 \times 0.966] = 0.575 \text{ feet.}$$

$$GZ_{90} = [0] + [-0.615 \times 1] = -0.615.$$

The results may be checked as follows:

GZ_0	0	½	0
GZ_{15}	0.176	2	0.352
GZ_{30}	0.916	1	0.916
GZ_{45}	1.560	2	3.120
GZ_{60}	1.392	1	1.392
GZ_{75}	0.575	2	1.550
GZ_{90}	—0.615	½	—0.307

$$GZ_a = 6{,}623 \times \tfrac{2}{3} \times 1/6 = 0.736 \text{ feet.}$$

$$h_{90} = 0.736\,\frac{\pi}{2} = 1.156 \text{ feet.}$$

$$p - BG = 9.75 - 8.585 = 1.165 \text{ feet.}$$

These two values check fairly well.

The stability curve can be plotted in the usual manner, using the above values of GZ as ordinates. From this curve

(*Continued on page* 487.)

Marine Engineering

Published Monthly by

ALDRICH PUBLISHING COMPANY

In Conjunction With

SIMMONS-BOARDMAN PUBLISHING COMPANY

6 East 39th Street and Woolworth Building, New York

F. B. WEBSTER, Editor
H. H. BROWN, Managing Editor

S. M. PHILLIPS, Associate Editor
A. J. KAUFMANN, Associate Editor
L. S. BLODGETT, Associate Editor
W. Z. GARDNER, News Editor

Contributing Editors

Rear Admiral C. W. Dyson, U. S. N.
Commander S. M. Robinson, U. S. N.
Professor C. H. Peabody
Captain C. A. McAllister, U.S.C.G. (Retired)
William Gatewood
H. McL. Harding
William T. Donnelly
James L. Bates

WE GUARANTEE that of this issue 6,500 copies were printed; that of these 6,500 copies 5,159 were mailed to regular paid subscribers, 326 were provided for counter and news company sales, 260 were mailed to advertisers, 85 were mailed to employes and correspondents, and 670 were provided for new subscriptions, samples, copies lost in the mail, and office use; that the total copies printed this year to date were 45,700—an average of 7,617 copies a month.

MARINE ENGINEERING is a member of the Associated Business Papers, Inc. (A. B. P.), National Association of Periodical Publishers, Inc., New York Business Publishers Association and the Audit Bureau of Circulations (A. B. C.).

A Real Administrator Necessary

THE manner in which the Shipping Board has functioned in the past with one or more commissioners assigned to the direction of certain departments, such as marine insurance, construction and operation, has probably been one of the chief reasons why big business men have shown a reluctance to accept the chairmanship of that board. It is a well-known saying that "a board is wooden," and it is only natural for a man who has made a success as a real business administrator to hesitate when asked to undertake the responsibility of the direction and development of our merchant marine where there is so much opportunity for interference with his plans by the other commissioners appointed from sectional regions and more or less dominated by sectional politicians.

Our merchant marine is of the greatest national importance both in peace and in war, and the chairman of the Shipping Board should be responsible for the administration of our shipping policies to the President alone. The other commissioners who should perform the services of counsellors or advisors, as in any well-regulated business, had far better be chosen for their knowledge and experience in marine matters than from the fact that they reside in a certain section of the country.

It is true that there are some judicial functions, such as the adjustment of claims, fixing of compensation for property commandeered in the war, determining rates and regulations, hearings of complaints, etc., where the Board can advantageously act as a unit, but the active administration of shipping policies, the establishment of adequate trade routes, the sale of ships and supplies, the daily problems occurring in connection with operating the fleet until it is sold and the decisions of such questions as will vitally affect the success or failure of our merchant marine should be under the control of one man, and that man should be the best that the country affords.

Protection for Shipping

MARINE ENGINEERING has consistently advocated that immediate action be taken to make possible the enforcement of the discriminatory custom duties, tonnage dues and preferential rail export rates specified in the Merchant Marine Act. Outside of the fact that a law on the statute book should be either enforced or repealed this magazine has repeatedly pointed out that the manufacturing and agricultural industries are protected while shipping is not.

The shipyard must pay higher wages for labor and higher prices for materials and equipment on account of the tariff and, in order to compete with foreign shipyards, some form of subvention must be received. The public will invest in shipping securities only when it sees a fair chance of a reasonable return and adequate American shipping cannot be developed without capital.

The Merchant Marine Act, by placing a premium on American-built vessels, aids shipbuilding as well as shipping. While other helpful shipping legislation is contemplated and should be enacted, the fact remains that the Government will have to charter its ships at rates that really mean a large subsidy to the operators or put into effect protection equivalent to that provided in the Jones Act. Why not give it a trial?

Shipping Is the Answer

HOW does it happen that the United States with an overabundance of money, food, cotton, copper, coal, steel and manufactured products, in fact most everything that other countries sadly lack, can be anything but prosperous? Is it not because we are afraid to ship our surplus products to other countries except on a cash basis F. O. B.? While it is considered to be a fundamental fact that one nation cannot be prosperous while others are depressed, a condition where such a state could not be remedied would only obtain where over production existed all over the world.

A movement of our surplus products to Europe would not only increase the demand for American labor and decrease the domestic price of our goods but it would also, and particularly in the case of raw materials, furnish the means of starting production in less fortunate countries. The English government has led the way in the solution of this problem by guaranteeing their manufacturers 80 percent of the invoice price of their exports. She has bought goods from us on a cash basis and sold them to other countries on long term loans and in the meantime her merchant marine has been getting a larger and larger percentage of the carrying trade.

History will show that maritime nations are the most successful because the prosperity of an industry is assured when there is a world-wide assimilation of its products. Each new market brings greater buying power and larger consumption. Larger consumption through quantity production reduces prices and low prices increase prosperity and make it possible to pay good wages.

American producers, be they engaged in manufacturing, mining or agriculture, must be made to realize the possibilities of our merchant marine. Agriculture and mining not only have a surplus to export, but a large percentage of their domestic trade is in the form of raw material for the manu-

facturing industry and when a surplus of manufactured goods accumulates that cannot be disposed of there is a back up all along the line.

The practical, profitable and patriotic thing that we should do is to develop our export market to the fullest extent by controlling our ocean freight through the employment of American vessels and including in the sales price of our exports the cost of transportation to their destination. In no other way can we know our markets or what is the comparative price of our competitors' goods. Are we hesitating again while even Belgium, which stood the gaff of the war, is making arrangements to supply Roumania with vast supplies of clothing on a five-year credit?

Naval Policy

In another column of this issue a résumé is given of a recent meeting of the Institution of Naval Architects, an organization that is national in character and unofficially in close relation to the British government. At the annual dinner in response to the toast of The Royal Navy a statement was given by the First Lord of the Admiralty which must be considered to be authoritative.

In this statement two points of great interest to us were made, first, that the capital ship is and will remain the best unit of seapower and that it will play in the future the same vital part in naval warfare that it has done in the past; the second point is that the British government accepts with equanimity the intention of the United States to have a navy equal to that of any other power. It is worth while to quote the words of the First Lord of the Admiralty as follows:

"That is a claim to equality which this country [England] has never accepted in the past and never would accept save in connection with the great English-speaking nation which has sprung from our loins, and which must ever hold a special place in our regard and confidence. We have, therefore, twice affirmed in the most formal way possible our acceptance for the future of a one-power standard; that is, that our Navy shall never be inferior in strength to that of any other Power."

Superheaters

It is surprising in view of the emphatic necessity for economy in the operation of our merchant marine that high degree superheaters have not been more generally installed on American ships. Particularly is this true in the case of turbine driven vessels, and Mr. Robert Warriner, chief engineer of the Bethlehem Shipbuilding Corporation, in his recent paper read before the May meeting of the Society of Naval Architects and Marine Engineers calls attention to the fact that, although the installation of turbines has shown a marked gain in economy over the reciprocating engine in actual service, these results could have been increased by the use of superheated steam with very little increase in the cost of the turbines. He states that "practically all that would be needed would be to make the high pressure end of the casing of cast steel instead of cast iron."

That the naval engineers of Japan are not unaware of the economy of utilizing the gases of combustion for superheating with the consequent saving in the amount of both fuel and water used is attested by the fact that the specifications for the 20,000-ton fuel ship recently awarded to the New York Shipbuilding Corporation direct that the boilers shall be equipped with superheaters capable of attaining a superheat of 200 degrees Fahrenheit. Of still greater import is the fact that the Cunard line, which has a most conservative reputation, is installing high degree superheaters in all its new passenger ships. America having led in the adoption of labor-saving devices should not allow other countries to lead in mechanical economizers.

Although President Harding clearly indicated in his message to Congress that America was determined to establish its merchant marine and that such aid as was necessary would be given, we take it, however, that this aid is not meant to cover wastes that can be avoided and we are even more certain that Congress will not be inclined to help the Shipping Board or private operators if they do not show a keen disposition to help themselves.

The Gas Turbine

Ever since the steam turbine became a commercial success, the minds of engineers and inventors have turned to the gas turbine with the hope of winning the same increase in economy that the gas engine has shown over the steam engine. It is fair to say that the best minds have turned away again, appalled by the difficulties of the problem.

Let us consider some ideas connected with the gas turbine. A naïve idea is to put explosive materials into a receptacle, explode them and let the resultant gases flow through the nozzles of a turbine. If we could afford to use T. N. T. or some other solid explosive material, so simple a solution of the problem might be possible; but unfortunately one of the elements for the explosion or combustion is atmospheric air; indeed it is the chief element both in volume and in weight. The only way of putting air into the combustion chamber is first to compress it in an air compressor, usually driven by steam. That is what is done to the charge of the torpedo in naval service. In the torpedo is a bottle of highly compressed air which flows into a chamber where an alcohol lamp burns; the hot gases drive a turbine on the propeller shafts. This is to date the only practicable gas turbine. To be sure, the leading idea is to warm the air and keep it from freezing up, but the result is a real gas turbine, though an inefficient one. The air compressor which is an indispensable part of the cycle of operations is driven by steam and kept aboard the ship which discharges the torpedo. The expense of the air is trivial compared with that of the torpedo, so why worry about economy?

Current literature reports the first *commercial* oil turbine, which is of course to inaugurate a new era in marine engines. This turbine is built by Messrs. Thyssen & Company at Muelheim, Germany, and is reported to consist of a combustion chamber and a turbine with specially heat treated electric steel blades. *Air is compressed in a separate air compressor driven by a steam motor.* The explosion pressure is limited to 205 pounds to keep the temperature within manageable limits, and the exhaust gases generate steam to drive the compressor. One's first impression is bewilderment and then a desire to see the heat balance of the combination. If it

can be accepted as the beginning of the solution of the gas turbine, then it appears that many of the troubles of the inventors are ahead.

So much has been done with special steels in recent years that we may provisionally accept the report that the special heat treated electric steel blades have operated satisfactorily at the temperatures to which they are subjected and yet we may wonder what the gases will do to the blades when the oil turbine is worked up to compete with the Diesel engine with its high pressure, high temperature and high economy. What material can be found that will stand such a combination of high peripheral speed, high temperature and erosion?

But why should we have a steam driven air compressor? Why not turn the steam generated by the exhaust gases into the turbine along with the gas from the combustion chamber? Why not gear the compressor onto the turbine? Why not have a centrifugal compressor? If a turbine can derive power from gases flowing through it, why should not a turbine reversed and driven at the proper speed draw in air and compress it? The ideal gas (or oil) turbine should be self-contained, carry its compressor on its main shaft, have an expansion comparable with that of the hot bulb engine and work at comparable temperatures. There is trouble enough ahead for the inventor who works toward such an ideal.

Immigration in American Vessels

FORESEEING the effect of restricted immigration on ocean-going passenger ships, Senator Jones has introduced a bill in the Senate limiting the transportation of immigrants to vessels flying the American flag. This bill must be regarded as a prohibitory rather than a discriminatory measure and, considering the trouble we are having in even starting the procedure that is necessary to modify existing treaties so that we may favor American ships with such preferential tariff rates that they can operate on the American standard of wages and living in competition with foreign vessels, it does not seem probable that this measure could be practically enforced should it become a law.

Our shipping policy, as we understand it, is to secure a reasonable share of commerce for American vessels; in other words to live and to let live. Although the United States might be able, because of its present financial position as compared to that of other countries, to so heavily subsidize American vessels that they could get all the business, such a policy would undoubtedly be detrimental morally and financially in the long run. The same would also be true of such drastic legislation.

On the other hand, if this bill restricted the immigration of foreigners to vessels of the country from which they embark and of the United States, it would not conflict with treaty provisions regarding direct trade. Such a law may be necessary if it is found that the passenger carrying trade between this country and another is monopolized by the ships of a third nation. Again, if immigration is restricted and companies operating both American and foreign vessels should favor their foreign ships by withdrawing the American vessels and placing them in the coastwise trade or in competition with established American lines, then such legislation may be necessary from the standpoint of self defense.

Ship and Sail on American Vessels

THE Shipping Board has entered into an advertising campaign to educate the shippers of this country on the advantages of shipping and sailing in American vessels. Undoubtedly the exporters and importers who travel back and forth across the ocean will favor those shipping lines with which they are familiar and no country can expect to get its share of business for its freight vessels if it ignores the importance of the passenger trade.

Recently complaint has been made that not only shippers but prominent Americans, including those in the employ of the Government, are traveling on British lines. The statement has been made that equivalent American ships are available, but this is not so. There are no *Aquitanias* or *Olympics* in the American service. We have chosen to let the *Leviathan* rot at her pier and have delayed the reconditioning of the *George Washington, America* and other German passenger ships, which could put up a first class service, while other countries have established new lines and enlarged their fleets.

American passenger liners are needed but they will not be forthcoming until the operating companies are assured that there is a chance of running them successfully in competition with foreign lines. The Shipping Board must recondition and charter its vessels on such terms as will make this possible and protection equivalent to that provided in the Jones Act must be obtained before new passenger ships will be ordered from American yards.

Shipbuilding Sustains Steel Corporation

THAT the earning power of the Bethlehem Steel Corporation has been sustained by its shipbuilding activities is evident from a comparison of that company's recent dividend action and the reports of such concerns as the Lackawanna and Republic steel companies. While it may be surprising for some people to learn that shipbuilding has bolstered up a great steel concern in times like these, yet even a casual examination of the reasons why Bethlehem still finds this industry profitable should be convincing.

Although the customary reports from the classification societies and other sources on the amount of work on hand in the shipyards usually fail to include the warships, the present naval program is a most important factor and in the case of Bethlehem it is the source of a very large amount of work. In addition to this, the corporation is building several large tankers and five ore-carrying vessels of 20,000 tons deadweight capacity, which, altogether, according to President E. G. Grace, is sufficient to keep the shipyards at Fore River, Sparrows Point and San Francisco, operating at full capacity for the remainder of the year.

While the shipyards have been a source of direct profit, incidentally, at a time when profits are highly desirable, they are also contributing work to the steel corporation by supplying orders for steel, armor, iron ore, coal and coke, which are all Bethlehem products. Important as the construction of these vessels is to Bethlehem, the ships themselves and the American merchant marine are still more valuable to the whole country as a means of creating markets for the nation's surplus products.

Approximate Stability Formulae

(*Concluded from page* 483.)

the angle of maximum stability, the greatest lever, and the range of stability can be determined.

These values can also be approximated by means of formulae (1) to (4):

(1) $\sin^2 \phi_m = \frac{1}{2} \frac{0.655 + 7.97}{9.24} = 0.467;$

$\sin \phi_m = 0.683;\ \phi_m = 43°.$

(The GZ curve gives $\phi_m = 50°$.)

(2) $\sin^2 \phi_k = 2 \times 0.467 = 0.934;$

$\sin \phi_k = 0.966;\ \phi_k = 75°.$

(3) $\phi_k = 90 - 120 \frac{0.615}{9.24} = 90 - 8 = 82°.$

(The GZ curve gives $\phi_k = 82°$.)

(4) $GZ_{max} = 1.78 - 0.615 \times 0.683 = 1.36$ feet.

(The GZ curve gives 1.60 feet at 50°.)

Cross Curves of Stability

For calculating the cross curves showing the righting levers with respect to the axis through the keel point, K, for various drafts and displacements, the values $B'K \sin \phi$ must be added to the calculated values of $B'Z\phi$ instead of $B'G \sin \phi$.

$$KZ\phi = B'Z\phi + B'K \sin \phi.$$

Repeating the calculation for a new draft, D_2, differing somewhat from D, the values of n_2 and p_2 can be obtained quite closely for full vessels, as follows:

$$n_2 = n - \tfrac{1}{2}(D_2 - D).$$

$$p_2 = \frac{n_2}{n} p.$$

The $KZ\phi$ values can be plotted in the usual manner, the results obtained by the above method being sufficiently accurate for practical purposes.

Stability Numbers

The expression $\frac{GM + n}{BM}$ in formulae (1), (2) and (4) as an abstract number seems to be well adapted for judging the stability of a vessel.

When $\frac{GM + n}{BM} = 1$, the vessel becomes unstable at 90 degrees.

When $\frac{GM + n}{BM} = 0.75$, the vessel becomes unstable at approximately 60 degrees.

Figures of this kind may be termed "stability numbers," since they qualify vessels with respect to their stability.

Suppose a vessel's requirements are: In the full load condition the virtual freeboard, f', shall be such that the range of stability covers 60 degrees with a minimum initial stability ($GM = 0$). Then we may write:

$$\frac{0 + n}{BM} = 0.75.$$

With $n = \frac{f'}{2}$, the required freeboard, f', equals:

$$f' = 1.5BM;\ \frac{f'}{BM} = 1.5.$$

For very full vessels with $BM = \frac{B_0^2}{12D}$, we get:

$$\frac{Df'}{B_0^2} = \tfrac{1}{8}.$$

When the virtual freeboard, f', of a modern cargo steamer is such that $\frac{Df'}{B_0^2} = \frac{1}{8}$, further stability calculations may be unnecessary.

A good average for cargo or passenger steamers is:

$$\frac{f'}{BM} = 1.$$

The simple relation, $f' = BM$, seems to give satisfactory stability conditions at sea.

NEW BOOKS

JOHNSON'S STEAM VESSELS, 1921. Twelfth edition. Size, 8⅝ by 4⅜ inches. Pages, 432. New York, 1921: Eads Johnson, M. E., Inc.

When this annual publication made its initial appearance in 1910, and for several subsequent years, it contained only a list of steam vessels in New York harbor. In the present edition the scope of the book has been widened so that the list covers steam vessels on the Atlantic, Gulf and Pacific coasts and on the Great Lakes. It gives in such form as to be convenient and instantaneously available the owner, name, age, material, type, hull dimensions, tonnage, engine and boiler dimensions and classification society of practically every steam vessel of American registry.

EXTRACTS FROM RULES. American Bureau of Shipping. Size, 5½ by 8½ inches. Pages, 38. New York, 1921. American Bureau of Shipping.

This pamphlet contains two sections of the rules of the American Bureau of Shipping which are new. They are: Section 36, covering internal combustion engines, which supersedes Section 36 of the previous issues of the rules; and Section 40, covering materials for machinery, boilers and piping, which supersedes Sections 40, 41 and 42 of the previous issues of the rules. Of special interest in the rules for internal combustion engines is the formula for determining the diameter of crankshaft, the derivation of which was discussed in a previous issue of MARINE ENGINEERING. The rules for materials for machinery, boilers and piping cover boiler material, steel, iron and bronze castings, steel and iron forgings, lap welded and seamless steel pipes, copper and brass plates, shapes, tubes and pipes.

STEAM BOILER ENGINEERING (Helios). Twenty-seventh edition. Size, 6 by 9 inches. Pages, 639. Illustrations, 423. St. Louis, Mo., 1921: The Heine Safety Boiler Company.

"Helios," which was first published by the Heine Safety Boiler Company in 1893, under the direction of the late Col. E. D. Meier, former president of the American Society of Mechanical Engineers and former president of the American Boiler Manufacturers' Association, now appears in new form and under a new name. Furthermore, the contents of the book have been completely revised and enlarged so that the present edition may be said to be entirely new. Briefly, it summarizes the latest commercial developments in boiler plant practice. It is in reality a handbook on boiler practice covering the theory of steam generation, the design of boilers, furnaces, chimneys, piping, auxiliary layouts and giving instructions for testing and operating boilers in accordance with the most approved methods. Although the book deals chiefly with stationary boiler installations, occasional reference is made to marine installations, especially in connection with such subjects as boiler settings.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

CONDUCTED BY JAMES L. BATES

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

Transporting Oil in Wooden Ships

Q. (1120).—I would like to know the feasibility of transporting fuel oil of 24 to 28 degrees Baumé in bulk in direct contact with a wooden hull in good condition, with a view to omitting steel tanks in a wooden schooner to carry oil in bulk and equipped with semi-Diesel type engines.

R. G. W.

A. (1120).—The information which you furnished is really not in sufficient detail to enable the proper answer to be made, even were the experience on this particular line wide enough to warrant a definite expression of opinion. In handling bulk oil care must be given to provide safety from fire, oiltightness and adequate stability of the vessel itself. There are in addition miscellaneous features, such as filling and discharge connections, cleaning, etc., but these are matters of detail.

It has been found that the fitting of large internal tanks, such as would be formed by the inner skin or ceiling of a wooden vessel, leaves inaccessible pockets in which dangerous gases may readily form. This objection would of course be largely avoided, if the vessel which you have in mind is not fitted with a wooden ceiling and the oil therefore allowed to come right out against the inner surface of the outer planking.

In wooden ships the planks are bound only indirectly to each other by means largely of their attachment to the frames. There is, therefore, no real continuity of structure. The longitudinal bending forces exert a strong tendency to make the planks slide lengthwise relative to each other. The friction of the calking between the planks helps somewhat to counteract this and provide rigidity and strength in the structure, but when the calking begins to give the hull strains and alters shape with comparative ease, especially when the vessel is old. In view of the above, considerable loss from leakage, due to the vessel's working in a seaway, might be expected, particularly where the oil is allowed to come right out to the vessel's outer skin and where the oil level within the compartment is considerably higher than the surface of the water outside the ship.

Whenever oil is carried in compartments a proper subdivision, both transverse and longitudinal, must be fitted in the vessel's hold so as to insure her stability. As you are doubtless aware, this generally results in a centerline and numerous transverse bulkheads in the case of the ordinary oil tanker.

Because of the foregoing, it would appear that the fire risks to be anticipated, the loss of oil during rough passage and the expense of converting the vessel for oil carriage would not warrant an attempt to utilize her in the manner suggested.

In case it was your intention to carry fuel for the vessel's own engines, rather than as bulk cargo, it is believed that an installation of steel tanks would, through a period of years, amply justify their initial cost. In this connection your attention is invited to the *Shipbuilding Cyclopedia,* 1920 edition, published by the Simmons-Boardman Publishing Company, of New York, in which certain wooden motor ships, recently designed by the firm of Cox and Stevens, New York, carry fuel oil in a number of small steel tanks. Also in MARINE ENGINEERING of February, 1921, you will find a short description of the so-called Ferris type of wooden ships fitted with oil burning boilers which also carry fuel oil in steel tanks. If such tanks are properly made and so installed as to be readily accessible, they afford, in the opinion of the writer, the best means of stowing oil for bunker purposes on board wooden vessels.

Crankshaft and Jib Crane Problems

Q. (1123).—(*a*) Given an 1,800 horsepower triple expansion engine, operating at 80 revolutions per minute, it is required to find the size of the crankshaft at the after side of the after crank. This must be found from first principles, and no formula as found in text-books may be used; also show position of cranks when maximum effort is exerted. This is a question given by the Canadian Government for their Civil Service examination.

(*b*) In a jib crane a load of 5½ tons is suspended at the end of the jib. If the jib is 16 feet 4 inches long and the horizontal stay is 7.25 feet long, find the load on the jib and stay.

W. P. C.

A. (1123).—(*a*) Assumptions: Same power developed in each cylinder; length of stroke, 40 inches; high pressure cut off at 70 percent; cranks placed at angles of 120 degrees; effect of inertia neglected; distance between bearings for crank shaft journal brasses, 30 inches.

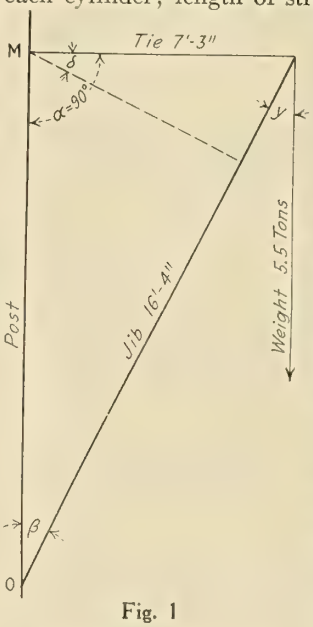


Fig. 1

These assumptions are in accordance with good practice for an engine of the above characteristics suitable for use in an ordinary cargo vessel.

The cross section of the crank shaft at the point stipulated must be of such size as to transmit the maximum turning effort of all three cylinders combined. It is necessary, then, to find first the value of this maximum turning effort and second the size of the shaft required to transmit it.

If a constant force were applied to the crank pin tangentially to its path, the work done per revolution would be

$$F \times \frac{2\pi L}{12},$$

where F is the force and L the length of the crank in inches.

Work done per minute =

$$F \times \frac{2\pi L}{12} \times R,$$

R being the number of revolutions per minute. $F \times L$ is the twisting moment continuously applied and the work done per minute is equal to I. H. P. $\times$ 33,000.

Then

$$I.\,H.\,P. \times 33{,}000 = F \times L \times \frac{2\pi}{12} \times R,$$

and mean twisting moment =

$$F \times L = \frac{I.H.P.}{R} \times \frac{33{,}000 \times 12}{2\pi} = \frac{I.H.P.}{R} \times 63{,}000.$$

In this case, the mean twisting moment for the engine =

$$\frac{1{,}800}{80} \times 63{,}000.$$

Investigation has shown that for a triple expansion engine having a cut off at 0.7 the ratio of maximum to mean twisting moment is 1.33. Maximum twisting moment becomes then:

$$\frac{1{,}800}{80} \times 63{,}000 \times 1.33 = 1{,}883{,}000 \text{ inch pounds.}$$

From this the maximum turning force on the after crank pin is:

$$\frac{1{,}883{,}000}{20} = 94{,}150 \text{ pounds.}$$

The stress in the cross section of the crankshaft results from the simultaneous application of the maximum twisting moment and a bending moment due to the force exerted by the connecing rod, a concentrated load, acting upon the crankshaft assumed to be a fixed ended beam.

This bending moment is:

$$\frac{94{,}150 \times 30}{8} = 353{,}000 \text{ inch pounds.}$$

The maximum equivalent twisting moment is found in the usual manner and is:

$$353{,}000 + \sqrt{353{,}000^2 + 1{,}883{,}000^2} = 2{,}268{,}000 \text{ inch pounds.}$$

On the basis of a solid shaft the diameter is found as follows:

Maximum twisting moment =

$$\frac{p_s I_p}{y},$$

in which p_s is the allowable working stress per square inch of material, I_p is the polar moment of inertia, and y is the radius of the shaft cross section.

$$I_p = \frac{1}{2}\pi r^4 = \frac{1}{32}\pi d^4,$$

in which r and d are respectively the radius and diameter of the shaft section.

$$y = \tfrac{1}{2} d.$$

The above expression for maximum twisting moment then becomes

$$T = \frac{p_s \pi d^3}{16} \text{ and } d = \sqrt[3]{\frac{T \times 16}{p_s \times \pi}} \text{ or } d = \sqrt[3]{\frac{T}{p_s}} \times 5.1.$$

If now we accept a working stress p_s of 6,000 pounds per square inch, we have

$$d = \sqrt[3]{\frac{2{,}268{,}000}{6{,}000}} \times 5.1 = 12.45 \text{ inches.}$$

If we allow a value of 8,000 for p_s, we have

$$d = 11.3 \text{ inches.}$$

The position of the cranks when maximum effort is exerted is dependent upon several different factors (mentioned below). But the information furnished is insufficient to make possible a satisfactory answer.

First.—The pressure of the steam ordinarily varies greatly at different parts of the stroke.

Second.—This varying pressure is transmitted to the crankpin by a connecting rod which changes its angle relative to the axis of the cylinder constantly throughout the length of the stroke.

Third.—An unequal distribution of power in the different cylinders frequently exists.

Fourth.—The effective turning effort upon the crank depends upon the weights and velocities of the various reciprocating parts as well as upon the variables previously mentioned.

In general the greater the number of cranks the more uniform the turning effort and twisting moment.

In order to ascertain the position of cranks at the time of maximum effort, in the present case, theoretical indicator cards would have to be assumed and a curve of twisting moment prepared for each crank, proper allowance being made for the effect of reciprocating parts. A curve of combined twisting moments could then be plotted and the points of maximum moment located thereon. This is a somewhat laborious operation and, considering the assumptions necessary, is believed to be unwarranted in the present case. Such diagrams are, however, worked out in

"Marine Engineer's Hand Book"—Sterling, page 934 to 937 inclusive.

"Manual of Marine Engineering"—Seaton, pages 182 to 184 inclusive.

"The Steam Engine"—Holmes.

(*b*) In Fig. 1 angle $\alpha = 90$ degrees (as tie is horizontal and the post is assumed vertical). Also angle β = angle γ = angle δ, from well known geometrical relationships.

Then

$$\sin \beta = \frac{7.25}{16.33} = .44397,$$

and angle

$$\beta = 26° \; 21' +.$$

Taking moments about O, the tension in the horizontal tie =

$$T = \frac{5.5 \times 7.25}{16.33 \cos \beta}.$$

Whence T = 2.73 tons (approximately).

Then taking moments about M, the crushing load in the jib =

$$C = \frac{5.5 \times 7.25}{7.25 \cos \delta}.$$

Whence $C = 6.14$ tons (approximately).

The above solution ignores the weights of the jib, tie, etc.

EDITOR TO AID HOOVER.—Frederick M. Feiker, vice-president and chairman of the editorial board of the McGraw-Hill Company, New York, has been granted a leave of absence to accept an appointment as assistant to the Secretary of Commerce. Mr. Hoover has divided the bureaus of the Department of Commerce into two parts. Assistant Secretary Huston will supervise the bureaus relating to navigation and fisheries, while Mr. Hoover will give his personal attention to the bureaus of foreign and domestic commerce, standards and census. Mr. Feiker will directly assist Mr. Hoover in the expansion of these bureaus as aids to business.

The immediate problem is to find out what kind of facts and figures industry needs from the government by means of a series of conferences with the representative men of industry. Having organized the department to function according to requirements, the next problem is to devise an adequate system of clearing the collected data back to business. Mr. Feiker's background of engineering training, viewpoint on the needs of industry and sense of publicity should be of unusual service in the furtherance of Mr. Hoover's plans.

PERSONAL MENTION

Juan Soldevilla, manager of the marine department of the Allianza de Santander, Barcelona, Spain, has been appointed surveyor for the American Bureau of Shipping. He graduated from the engineering department of Barcelona University in 1898, and from E. S. B. School, Liege, Belgium, in 1900. Since then he has carried on the study of shipbuilding and the practice of naval architecture at the Arsenol Civil of Barcelona.

D. C. Young, for the past nine months chief surveyor in charge of the Seattle and Portland offices of the United States Bureau of Survey, has been appointed representative of the American Marine Insurance Syndicates at San Francisco, Cal. Born in Govan, Scotland, Mr. Young served his apprenticeship in engineering with the Smith Dry Dock Company, Ltd., on the Tyne, England. Subsequently he had sea-going experience in various grades, including that of chief engineer. Mr. Young came to the United States in 1909, and is now a naturalized citizen of this country. For about four and a half years previous to taking charge of the Seattle and Portland offices of the United States Bureau of Survey, Mr. Young was general manager of the Hanlon Dry Dock & Shipbuilding Company, Oakland, Cal.

D. C. Young

Truman A. Gamon and A. Harold Jansson have formed a partnership as naval architects and ship surveyors with offices at 50 Union Square, New York.

Mr. Jansson is a graduate of the Massachusetts Institute of Technology, class of 1907, in naval architecture and marine engineering. Upon graduation he was engaged in hull construction work at the Bath Iron Works for a short time, after which he returned to the Institute, where he held the position of instructor in naval architecture for the next two years. His subsequent experience includes two years in machine shop work at the plant of The William Cramp & Sons' Ship & Engine Building Company, four and one-half years with the Welin Marine Equipment Company (two of these being in the capacity of naval architect), four years with the Munson Steamship Line supervising the construction of new ships and the reconstruction, repair and maintenance of ships operated by that company. He was also employed for a short period assisting in an analysis of cost operation of ships for the Furness Withy Company.

Mr. Gamon graduated from the department of naval architecture at the University of Michigan in 1910. His experience includes five years at the experimental model basin, Washington, D. C., one year in the scientific department of The William Cramp & Sons' Ship & Engine Building Company, one year in the scientific department, Bureau of Construction and Repair, United States Navy Department, one year as designer for the Welin Marine Equipment Company and three years as plant manager of the Welin plant, American Balsa Company, New York.

J. D. Tomlinson, formerly operating manager of the United American Lines, Inc., has been elected vice-president of the American-Hawaiian Steamship Company.

Henry Dearborn has been elected president of the American-Hawaiian Steamship Company, which position was formerly held by the late George S. Dearborn, one of the pioneers in American shipping.

Robert B. M. Wilson has been appointed sales engineer of the Conveyors Corporation of America in the Chicago district. Mr. Wilson has had a number of years' experience in railroad construction and maintenance.

Albert Christen has recently been appointed general superintendent of the Consolidated Shipbuilding Corporation, Morris Heights, N. Y., to succeed Joseph S. Potter, who has been promoted to the position of sales engineer.

W. A. Harriman has been elected chairman of the boards of directors of the American-Hawaiian Steamship Company, the American Ship & Commerce Corporation and the American Ship & Commerce Navigation Corporation; he is also chairman of the executive boards of the United American Lines, Inc., and the Merchant Shipbuilding Corporation.

Sir John Luscombe has recently been appointed chairman of Lloyd's Register. Sir John is a well known underwriter at Lloyd's, and was elected as member of Lloyd's in the year 1870. He has held the chairmanship of Lloyd's for the years 1902, 1908, 1909, 1912 and 1914. He was deputy chairman and treasurer of Lloyd's Register of Shipping from July, 1904, to June, 1906, and from July, 1919, up to the present time.

David Sarnoff, formerly commercial manager of the Radio Corporation of America, New York City, was appointed general manager of this company at the recent meeting of the board of directors. Mr. Sarnoff will supervise and control the operation of the corporation's plant and in general will have charge of the high and low power ship stations and the maintenance of radio service. He will also have charge of the corporation's trans-oceanic communication system and the handling of negotiations for the sale and rental of apparatus. Mr. Sarnoff was born in Russia in 1891, and came to the United States in 1900, where he was first employed as a wireless operator at the Marconi station, Siasconset, Mass. Later he became manager of the Marconi station at Sea Gate, N. Y. Mr. Sarnoff is vice-president and a director of the Pan-American Wireless Telegraph and Telephone Company and was secretary of the Institute of Radio Engineers from 1915 to 1917. He is the author of several important papers on radio work.

David Sarnoff

J. Herbert Scrutton, a partner of the firm of master porters, stevedores, etc., Scrutton Sons & Company, who operated until last February a line of passenger and cargo vessels between London and Glasgow to the West Indies, has been appointed deputy chairman and treasurer of Lloyd's Register in place of Sir John Luscombe. Mr. Scrutton was chairman of the General Shipowners' Society for the years 1905 to 1906 when he first took his seat on the committee of Lloyd's Register and on which he has since served continuously.

Shipbuilding and General Marine News

Contracts for New Ships — Shipyard Improvements — Engineering Projects—Improved Appliances—Personal Items

Atlantic Coast Shipbuilders' Association Expands to Include Dry Dock and Repair Yards

Recognizes Claim That Equal in Importance to Building Ships Is Keeping Them in Repair — Annual Meeting Hears Interesting Reports and Elects Officers

Extending its field of usefulness to cover the entire shipbuilding industry, the Atlantic Coast Shipbuilders' Association, membership in which heretofore was confined to shipyards engaged in the construction of steel vessels, at its annual meeting in Philadelphia, Monday, May 9, adopted a recommendation made by Clarence Samuel King in his annual report as secretary that an effort be made through a membership committee to bring within the association every shipbuilding and repair plant on the Atlantic seaboard and Gulf of Mexico, with the view of establishing closer business relations, securing united and co-operative action on the fundamental problems of the industry, and standardizing as far as possible the conditions under which marine work is done.

This action recognizes the claim of dry dock and marine repair plants that equal in importance to building ships is keeping them in repair, and opens the way for an organization more or less national in scope which will continue along the conservative but constructive lines that made the Atlantic Coast Shipbuilders' Association a powerful and influential stabilizing force during the war and an even greater facteor in the transition from war to peace.

With a membership comprising substantially every recognized shipyard on the Atlantic and Gulf coasts engaged in building steel vessels, the association will now have the co-operation of many repair yards, of which there are approximately 140 in the east, in its determination to further the American merchant marine and establish shipbuilding as a permanent American industry.

The meeting brought to Philadelphia representatives of every shipbuilding district in the east, some of the shipyards sending delegations consisting of as many as seven members. The territory represented extends from Bath, Me., along the Atlantic Coast and Gulf of Mexico to New Orleans, La. Sessions were held morning, afternoon and evening, with the annual dinner at the Bellevue-Stratford Hotel as the outstanding entertainment feature.

While the executive officers of the various shipbuilding companies were discussing the merchant marine and the future of shipbuilding as a permanent American industry, experts to whom were assigned the more technical problems of ship construction held a conference on general shipbuilding problems. The labor situation came in for a large share of attention at the general conference, which was held throughout the afternoon in the association's large suite of offices on the second floor of the Estey building, and steps were taken to standardize wage rates, hours of labor and conditions of employment by making uniform as far as possible in each local shipbuilding district wage readjustments and construction cost liquidation now under way.

Many of the association's important activities were reviewed in the reports of the chairmen of the various committees under whose direction the special subjects were handled. H. Birchard Taylor, vice-president of the Wm. Cramp & Sons Ship and Engine Building Company, president of the association, and W. G. Coxe, vice-president and general manager of the Pusey & Jones Company, with shipyards at Gloucester, N. J., and Wilmington, Del., as chairman of the executive committee, discussed the work of the administrative council, in which is vested the government of the association and the administration of its business and affairs. They emphasized the readiness of the association to protect the interests of its members in conditions that continually arise in the shipbuilding industry, with its many policies to be formed, attesting to the splendid spirit of loyal co-operation in which the members have worked together, and pointing out the accomplishments of great mutual benefit that have come through these collective efforts.

R. H. M. Robinson, president of the Merchant Shipbuilding Corporation, reported that the general committee, of which he is chairman, expects during the coming year to initiate certain activities in connection with ship financing, which plans and other recommendations of policy will be announced as soon as the committee has had an opportunity to review and co-ordinate the work of the committees on contracts, classifications, cost accounting, labor board and marine and plant insurance.

The committee on marine and plant insurance, through its chairman, Frederick P. Palen, vice-president of the Newport News Shipbuilding and Dry Dock Company, reported that an investigation shows that builders' risk insurance, which is of first importance to shipbuilders, is very well standardized as to the policy forms, and the rates charged are so nearly uniform that the committee did not consider it necessary to recommend any changes from the present practice.

As a development of the association's policy to deal intelligently with and to improve the conditions of production and employment in the shipyards, the Atlantic Coast Shipbuilding Industrial Board, created by agreement between some members of the association and the Metal Trades Department of the American Federation of Labor, was described by its chairman, William T. Smith, vice-president of the Merchant Shipbuilding Corporation. According to Mr. Smith, the purpose of the board is to promote continuity of employment and uninterrupted production in the signatory shipyards, one clause of the agreement providing that no strike or cessation of work by employees or lockout by builders shall occur during the life of the agreement. The primary functions of the board are to interpret, determine and enforce the standards of wages, hours, classifications and working conditions in the signatory shipyards. This agreement was executed August 20, 1919, to endure for one year, and has since been continued without date, provision being made that any signatory can withdraw upon thirty days' notice.

Another important work which the association has undertaken and successfully consummated, according to George D. Martin, comptroller of the William Cramp & Sons Ship and Engine Building Company, is that of developing uniform methods of cost accounting for the shipyards.

The past year witnessed the first study given the subject of ship classification by the association members as an organization, this work being directed by W. A. Dobson, naval architect of the William Cramp & Sons Ship and Engine Building Company, who several months ago accepted the chairmanship of the committee on classification, and since then has been in close co-operation with the American Bureau of Shipping, which invited suggestions from the committee to improve the usefulness and efficiency of the Bureau. Mr. Dobson's report analyzed the classification work of the American Bureau of Shipping and gave a brief resumé of recommendations which the committee believes will be helpful to the Bureau and will increase its standing as a thoroughly efficient classification society.

Paul Gendell, employment manager of the New York Shipbuilding Corporation, reported as chairman of the employment managers' committee on the co-operation

that has prevailed among the heads of the shipyard employment departments.

The new Administrative Council organized immediately following the installation of its members and elected officers of the Association for the ensuing year as follows:

President.—James Lee Ackerson, vice-president Merchant Shipbuilding Corporation.
Vice-President.—George H. Bates.
Treasurer.—Sidney M. Henry.
Secretary.—Clarence Samuel King.

SHIP REPAIRED

One Hundred and Ninety Shell Plates Removed and Rerolled for Steamer "Nedmac"

The S. S. *Nedmac* went on the rocks some months ago off the British Isles. After undergoing emergency repairs in England the ship crossed the Atlantic, but on arrival in American waters was found to be in such a serious condition, owing to warping of the hull plates and resultant leaks, that it was immediately ordered into dry dock. Examination of the hull disclosed the necessity for removing and rerolling 190 shell plates.

New Hudson River Steamer

The new Hudson River Day Line steamer *De Witt Clinton* received her first grooming Thursday, May 12, in a trial spin up the Hudson. The steamer was built in 1913 for the Grand Trunk Railway, but was never put in commission until operated by the United States Navy, when she made an honorable war record for about seven months. She is 340 feet long, with extensive outside deck area, the work of transformation having recently been completed by the Todd Shipyards Corporation at the Tietjen & Lang yard.

In anticipation of the initial trip up the Hudson, a brass-bound cask containing some of the water of Lake Erie was brought from Buffalo in the care of George Clinton, an eminent lawyer of that city and a grandson of De Witt Clinton, for whom the steamer is named. When the party reached a point opposite the Hudson River Day Line pier, Mr. Clinton emptied the cask into the Hudson, thus repeating the ancient ceremony which was performed by his illustrious grandfather De Witt Clinton, at the opening of the Erie Canal in October, 1825.

Growing Trade for Vessels Arranged for Ventilation and Refrigeration

The Atlantic Gulf & Pacific Steamship Corporation reports that the *Henry S. Grove* is now bringing a shipment of 1,000 cases of fresh eggs, as a trial shipment, in addition to 50,000 boxes of citrus fruit and general cargo from the west coast. It will be remembered that the *Charles H. Cramp*, another vessel of their fleet, had the distinction of bringing the first shipment of fruit via the Panama Canal to Atlantic coast ports.

Lester Collins, refrigeration technologist for the Department of Agriculture, made the trip on the *Cramp* on her first voyage as a fruit carrier, and in company with A. H. Haag, marine superintendent of the line, thoroughly inspected the fruit upon its arrival in Philadelphia. It is most interesting to note that the total decay was less than 5 percent, and in many instances less than 1 percent, which is a far better result than can be obtained by rail shipments.

The importance of this trade to our merchant marine is emphasized by the fact that the Atlantic, Gulf & Pacific Steamship Corporation has not had one ship idle during the existing shipping slump.

Electric Drive Ship Eclipse Completes 26,500-Mile Voyage Showing Notable Performance

The S. S. *Eclipse*, of the United American Line, America's first electrically-propelled cargo carrier, docked at pier 21, Staten Island, on May 19, having completed her first ocean voyage with her new electric drive—a trip of 26,500 miles, without the slightest hitch to any of her machinery.

She was met at Quarantine by H. B. Taylor, chief turbine engineer of the United States Shipping Board, who congratulated the officers of the boat on the fine performance of her equipment and the complete success attending her initial trip.

The *Eclipse* left New York on November 12. Her first stop was Port Said. She then proceeded to Singapore and Java, took on a cargo and left Bombay on her return, March 23. Both going and coming she encountered heavy seas, but maintained a speed of better than 10 knots, covered the distance, it is claimed, in one week less time than required for similar boats not equipped with the electric drive and with a great saving in fuel used, as compared with trips taken by her before her propulsion machinery was changed from the geared turbine to the electric drive.

Capt. A. J. Shrader, of the *Eclipse*, declared as he left his cabin when the vessel docked that the trip had been the best in his experience, that not the slightest trouble had occurred in any part of the equipment.

"There is no comparison between the electric drive on this boat and the geared turbine or the reciprocating engine drive." He said, "I have had considerable experience with the geared turbine propulsion, and this beats it in every way. We made every port on schedule, maintained a speed of better than 10 knots for the entire trip, and I can say nothing but words of praise for the equipment."

His remarks were duplicated by Chief Engineer Carageorge and by others on the ship. From the quarantine engineer it was learned that the *Eclipse* had saved two months for the trip over vessels without the electric drive.

One passenger was brought back, Col. W. A. Castle, military attache to the American High Commission at Constantinople.

The *Eclipse* was built at the Bethlehem Shipbuilding Corporation's Union Iron Works, San Francisco, in 1918. Last summer her propulsion apparatus was changed by the Shipping Board to the turbine electric drive. Contrary to reports that special electrically trained men would be required to operate the vessel, the same crew which manned the *Eclipse* before the change was used, and not the slightest difficulty was experienced. Engineers operated the vessel as easily as a motorman does a trolley car, its simplicity being one of the marked features of the trip.

In addition to the many economical advantages of the electric drive over steam engine or other type propulsion, the *Eclipse* has been found much easier to control. The pilot, who has held such a berth for 35 years, declared that the *Eclipse* was under better control than any ship with a different type drive he had ever been on. Tests have shown that the propeller can be reversed from full speed ahead to full speed astern with ease in 10 seconds. Then, too, there was a uniformity of propeller speed, which prevented racing of the propeller in heavy seas, and the total lack of vibration.

The *Eclipse* is the first of twelve 12,000-ton vessels being equipped by the General Electric Company with the electric drive for the Shipping Board. Her electrical equipment consists of a steam turbine and a 2,300-volt generator, driving a 3,000-horsepower motor at 100 revolutions per minute.

SHIPOWNERS' PROBLEMS

Association Names Technical Committee for Representation

An important movement toward more comprehensive handling by American shipowners of problems relating to structural standards for American ships, especially with reference to bulkheads as well as to load-line regulations, general design and engining, has been instituted by the American Steamship Owners' Association, 11 Broadway, New York.

Feeling that the shipowners should have the best technical representation in national and international conferences dealing with these problems, and deliberations of every character relating to legislation and the adoption of official regulations intended to improve American merchant ships, the owners' association has appointed a special technical committee to represent it in such matters.

The members of the committee are as follows:

William Francis Gibbs, chief of construction, International Mercantile Marine Company, chairman.

Capt. O. W. Koester, vice-president in charge of construction, United States Mail Steamship Company.

John H. Telford, superintending engineer, Munson Steamship Line.

C. A. Ward, Jr., naval architect, Merchant Shipbuilding Corporation.

A. S. Hebble, superintending engineer, Southern Pacific Company.

James Donald, president, States Marine & Commercial Company, Inc.

Warren T. Berry, superintendent, marine construction, New England Steamship Company.

PORT IMPROVEMENTS

Large Sums to Be Expended for Development of Harbors

Approximately $1,750,000 worth of docks, wharves, warehouses and storage yards comprising several units of the final port development plans are about to get under way at Wilmington, Del. The plans, which comprise the last word in engineering achievement, call for the creation of a port along the banks of the Christiana, one mile from the Delaware river, into which the Christiana flows, that the Board of Harbor Commissioners of this city believe will eventually make this port one of the most prominent along the eastern coast, even though it is a matter of 60 miles inland from the Atlantic.

The initial project will consist of a quay wall approximately 1,200 feet in length, of skeleton concrete construction supported on timber piles. At the upstream end will be located a coastwise cargo shed for the accommodation of boats requiring side port loading. At the lower end will be a transit shed 400 feet long by 120 feet wide flanked by a wing shed 500 feet long by 120 feet wide for the temporary storage of cargo. Between these buildings and the coastwise cargo shed will be an open storage yard, where heavy machinery and other bulk cargo not affected by the weather may be stored. Back from the river front a car classification and temporary holding yard will be built. Minor buildings such as pump house, cafeteria and locomotive house are also included in the design. A water tower will be supplied. The development will be connected by a concrete roadway with Christiana avenue, which will link it up with the state highway system. It is expected that mechanical appliances will be used to a large extent in handling cargo, and to this end provision is being made for the installation of gantry cranes, both heavy and light tractors and trailers, industrial trucks, an escalator in the coastwise storage shed, and cargo masts along the face of the main transit shed.

NEW YORK

For dredging the main channel up to the head of Mill Basin to a depth of 18 feet, and necessary retaining walls along the bulkhead line so that the channel may be dredged along Flatbush avenue, Brooklyn, the New York Board of Estimate and Apportionment has authorized the issue of corporate stock to the amount not exceeding $750,000. The Board has also adopted a resolution authorizing the issue of serial bonds in the amount of $175,180, to be used by the Department of Plant and Structures for reconstruction work at municipal ferry terminals. The expenditures will be as follows: For reconstruction of racks and bridge at St. George, $68,160; at Whitehall street, $44,510; at South street, $13,770, and at 39th street, Brooklyn, $48,740.

NORFOLK

At Norfolk, Va., the city, through its port commission, which body was created by the Council, is contemplating the construction and erection of additional pier facilities, with a grain elevator adequate to meet the local needs.

Four Million Dollars to be Invested By New York City in Ferryboats and Equipment

Approximately four million dollars will be New York's latest investment in municipal ferryboats, terminals, equipment and operation, according to official information obtained by MARINE ENGINEERING. The projects now under consideration, and which are believed to be moving rapidly ahead, include the building or purchase of steamers, the construction of new and repair of old terminals and the reconditioning of boats now in use. Seven routes, including the Stapleton line, are in the present programme.

The services are as follows:

Classon Point to College Point, which it is hoped to start about July 1. A slip is to be built at Classon Point.

From East 23d street, Manhattan, to Greenpoint avenue, Brooklyn. This line is now under a private ownership, which has served notice of its intention to quit. Three boats may be purchased and about $30,000 spent on the terminals.

It is proposed to re-establish service between Broadway, Williamsburgh, and Grand street, Manhattan, which service was abandoned three years ago. The sum of $742,000 has been asked for this line, of which sum $480,000 will probably be spent for either the purchase of two boats or the building of two new ones. It is understood that these craft must be from 170 to 190 feet in length, in order to accommodate the traffic.

The Union Ferries, which Commissioner Whalen has recommended be taken over by the city and which run from Fulton street, Manhattan, to Fulton avenue, Brooklyn; Whitehall street, Manhattan, to Atlantic avenue, Brooklyn, and Whitehall street to Hamilton avenue, Brooklyn, the latter being considered of vital importance to the Red Hook section of Brooklyn.

For operation during the remainder of the year, $600,000 will be requested, although it is estimated that the operating receipts will reach a total of $750,000.

The lines enumerated are in addition to the new service to be established between lower Manhattan and Stapleton, S. I.

The Classon Point and Broadway-Grand street projects have been approved by the Sinking Fund Commission, it was stated. All are pending in the Board of Aldermen, and it was estimated that during the coming month most, if not all, of the projects will have reached the appropriation stage.

Commissioner Whalen, it is announced, has studied the disparity in cost of operation between municipal and private ownership, and has laid out a system of operation incorporating radical economies, which he believes will enable the city to operate these ferries at a very small increase in cost as compared with past experience with private operation.

America to Build 20,000-Ton Electrically Propelled Fuel Ship for the Japanese Navy

Japan is to be the second nation to use the electric drive in its navy, a contract having just been closed with the New York Shipbuilding Company, of Camden, N. J., for a 20,000-ton fuel ship, similar in size to the U. S. S. *Jupiter*, recently named the *Langley*. The design of the vessel calls for a waterline length of 496 feet, with a beam of 67 feet.

Interested in the success of the electric drive, proven by the ten years' service of the *Jupiter* and the two years or more of practical service of the U. S. S. *New Mexico*, the world's first electrically-propelled battleship, Japan has decided to follow America's steps in first electrifying a smaller navy ship. There is no doubt that if this vessel operates successfully future large ships of the Japanese Navy will be electrically propelled.

It was through the untiring efforts of Captain M. Yokura that the Japanese Government decided to introduce the electric drive in its navy. Economy in fuel is of paramount importance, and Captain Yokura therefore decided to install electrically-driven auxiliaries throughout, as well as to equip the boilers with superheaters so as to obtain about 200 degrees F. of superheat. This last mentioned improvement will mean a fuel saving of at least 10 percent.

The G-E equipment, purchased from the International General Electric Company, will consist of an 8,000-horsepower turbine generator supplying power to two 4,000-horsepower 120 revolutions per minute, synchronous motors; also two 500-kilowatt direct-current turbo sets, one of which is to be sufficiently large to furnish the exciting current for the main generating units, as well as power to drive all the auxiliaries, such as the blower motor, steering gear, the gypsy, radio apparatus, refrigerating plant, laundry and lighting equipment.

There is also furnished a 650-kilowatt alternator, which can be connected by means of a coupling to either of the 500-kilowatt, direct-current auxiliary turbines, so that in case of failure of the main driving unit, or any of its auxiliaries, this small generator will give sufficient power to propel the vessel at about 7½ knots.

This Japanese fuel ship will be completed in twelve months' time, and is expected on her trials to make a record in fuel economy because of her watertube boilers of 270 pounds gage steam pressure with 200 degrees F. of superheat, and the fact that synchronous motors are to be used for the main drive and that all auxiliaries are to be electrically operated. The vessel will have Isherwood longitudinal framing.

Marine Construction News of the Month

Ship Contracts—New Ship Concerns and Shipyard Improvements—Terminal Projects—Government Contracts

SHIPS AND SHIPBUILDING

Light Vessel Repair.—Repairs and docking of light vessel No. 49 has been awarded by the Bureau of Lighthouses to the Spedden Shipbuilding Company, Baltimore, Md.

To Build Three Lighters.—The Dravo Construction Company of Pittsburgh, Pa., were low bidders for three 60 foot steel lighters for the Shipping Board, the price being $10,500 each.

Repairing Steamer, Brooklyn, N. Y.—On a bid of $8,750, the Morse Dry Dock & Repair Company was awarded the contract to repair the steamer Honnedaga, a Shipping Board vessel.

Drydock.—The Jahncke Dry Dock company is building an 8,000 ton steel drydock, and is reported to have purchased the plant of the Crescent City Machine & Manufacturing Company.

Tankers, for English Interests—Recent reports from London state that the Eagle Oil Transport Company, Ltd., expects to lay down four more 11,000-ton tankers in an American shipyard.

Shipyard Sold.—It is reported that Irving W. Reed has purchased the shipbuilding plant which he had sold to the East Coast Ship Company, and will soon start building small boats as he did in past years.

To Rebuild Yard.—The National Shipbuilding Company, Goderich, Ont., will rebuild and install new equipment at its plant which was recently destroyed by fire. The entire cost will amount to about $100,000.

Radio Installations on New Vessels—A contract for installing two kilowatt 500 cycle radio sets on four new tankers under construction for the Standard Oil Company has been awarded to the Radio Corporation of America.

To Refit and Overhaul Schooner, Philadelphia, Pa.—The American schooner Hortense has been sold by the United States marshal at Pensacola, Fla., to O'Hara Bros. & Company, of Philadelphia, Pa., for $6,200. The vessel will be refitted and overhauled.

New Fireboat, Norfolk, Va.—Latest and official advices from the city of Norfolk, Va., are to the effect that the city is about to purchase a new fireboat and is making a study of the comparative merits of a steam propelled craft against a gasoline propelled craft.

To Overhaul Vessel, San Francisco, Cal.—The steamer Admiral Farragut, of the Admiral Line, has completed her last run on her South American schedule, and will be laid up temporarily for fumigation and a general overhauling. The number of her cabins will also be increased by five.

Barges, Pensacola, Fla.—The Pensacola Shipbuilding Company has contracted to build for the Alexandria Coaling Company, New Orleans, La., two 600-ton coal barges, 135 feet in length and 30 feet beam. It is reported that four smaller steel oil barges will also be built for a Tampico oil company.

To Repair Vessel, Brooklyn, N. Y.—The contract for repairs to the Shipping Board steamer Porto Rico has been awarded to the Robins Dry Dock & Repair Company, Brooklyn, N. Y., on their bid of $9,300. The work includes among other things the installation of six new furnaces of the Morison type.

To Ask for New Pump Bids, New York—It was learned to-day that bids submitted on April 4 for the installation of turbine fire pumps on the New York fireboats James Duane and Thomas Willard have been filed, and new tenders may be asked for later. The previous bids ranged from $30,000 to $48,000.

Zulia Contract Awarded, Chester, Pa.—The contract for reconditioning the Red "D" steamer Zulia has been awarded to the Sun Shipbuilding Company. It is understood that the work contemplates the installation of an oil-burning system, and will involve the expenditure of approximately $100,000.

Victorious Contract Awarded.—Announcement is made of the awarding of the contract for installing electric drive in the steamship Victorious, of the Shipping Board to the Tebo Yacht & Basin Company, Brooklyn, N. Y. It is stated that the cost will be $95,530, which includes voyage repairs and betterments.

Six Dumpers Contemplated—According to information obtained by MARINE ENGINEERING, construction of six sea dumpers is contemplated by the Street Cleaning Department of the city of New York No definite date for issuing the plans and specifications has been given. It is believed that these boats will cost close to $200,000.

May Convert Ten Ships.—Decision to convert ten 3,800 ton steel cargo carriers into refrigerator vessels for the purpose of operating them on the intercoastal service under an arrangement with the California Fruit Grocers' Exchange is accredited to the American Shipbuilding Company. An agreement with the Fruit Growers' Exchange is reported to have been reached recently at Los Angeles.

To Recondition Steamers, Brooklyn, N. Y.—Following the awarding of the contract for installation of third class passenger accommodations in the Shipping Board steamer Centennial State to the Robins Dry Dock & Repair Company at a price of $128,000, it was announced that three additional "State" ships will follow the Centennial State for similar reconditioning.

Completing Plans—Latest authoritative information is to the effect that a force of men is now engaged in completing plans and specifications for the reconditioning of the Agamemnon and Mount Vernon, and the opinion was expressed that the work would be put out for competitive bidding after the vessels have been turned over to the steamship line by the Shipping Board.

Overhauling Vessels, Hoboken, N. J.—The steamships Bristol and Fairmont of the United American Line went to the yards of the W. & A. Fletcher Company for dry docking, a general overhauling, and machine and tank equipment work. The Shipping Board steamer Collingsworth is also at this yard for renewal of bow plates, hawse pipes, repairs to stem, machinery, decks, hull and top sides.

Moore Yards Busy, Oakand, Cal.—Work is being rushed on the freighter Ohioan of the Williams-Diamond Line, which is now in drydock at the Moore Shipbuilding Yard. The vessel is having new blades attached to her propeller and her tail shaft is being drawn. The Shipping Board freighter West Keene is being overhauled and repairs are also being made on the Alaska Packer's ship Star of Russia.

Repairing Steamer, Hoboken, N. J.—A contract for repairs to the Shipping Board steamer Eastern Moon was awarded by the Shipping Board to the W. & A. Fletcher Company on their bid of $17,050. Other bids were: Robins Dry Dock & Repair Company, $17,850; Morse Dry Dock & Repair Company, $23,900; Baltimore Dry Dock & Shipbuilding Company, $24,105; James Shewan Son, $25,994. The work includes the renewal of the ship's stern frame.

Suction Dredges, New York—Designs for two 15-inch suction dredges to be built in this country and shipped in knock-down sections to India are in the hands of N. E. McClelland & Company, Ltd., naval architects, 2 Stone street. The order for these craft was received through the engineering concern's Canadian office. Plans and specifications will not be completed for about six weeks although it is understood that the dredges will cost in the neighborhood of $175,000 each.

Tug, Dredge, Scows, Detroit, Mich.—The Department of Parks and Boulevards, Marquette Building, has let contracts for furnishing combination 16-inch hydraulic and 2½ yard dipper dredge to W. Logan, Jr., Waterford, N. Y., at a cost of $42,000; three scows, 12 by 34 by 125 feet to the Canal Construction Company, North American Building, Philadelphia, Pa., to cost $50,000; and contract for a steel tug and wooden scow No. 9 to E. Gray, Gray Haven street, $25,000.

To Convert Turbines—Announcement is made of the awarding of the contract by the Shipping Board to the General Electric Company for the modification of ten 2,500-horsepower marine turbines that were built for 200 pounds pressure, 50 degrees of superheat, for 200 pounds pressure and 250 degrees superheat, which is expected to cut the fuel consumption about 20 percent. This does not include the steamship Volunteer, which makes a total of eleven turbines to be converted.

To Recondition Liners—The placing of contracts which will call for the expenditure of over two million dollars, involving the reconditioning of the steamships Agamemnon and Mount Vernon, by the United States Mail Steamship Company, is being awaited with considerable interest in ship repair circles in New York and vicinity. Although definite dates are not available at this time, it is believed that the work to be done on these two ships will be ready for bids in the near future.

Dredger, Antwerp, Belgium—The port authorities are asking for tenders for the supply to the port of one dredger, which will be capable of dredging to a depth of 15 meters (about 49 feet) beneath the water level. The dredger must be provided with a main engine of the horizontal or vertical type, compound, with two cylinders, working with steam saturated at 10 atmospheres. The boiler should have two Morison furnaces. Seven steam windlasses are also to be supplied. The buckets should have a capacity of a least 600 liters (about 160 gallons). Further particulars can be obtained from the secretary of the Antwerp Town Hall.

Ferryboats, Boston, Mass.—The City of Boston is expending at the present time, under contracts made last year, approximately $1,165,000 for the improvement of the ferry service. This work includes two new steel ferryboats of the 4-roadway type and one reconstructed ferryboat to provide for four teaming roadways; also certain changes in the entrances and exits which will allow two lines of traffic to and from the boats in place of the 1-line entrances and exits. One of the new boats is being built by the Groton Iron Works, Groton, Conn., at a cost of $379,950, and the other by the Winnisimmet Ship Yard, Inc., Chelsea, Mass., at a cost of $335,000, and the rebuilding of the other boat is being done by the Richard T. Green Company, Chelsea, Mass., at a cost of $165,000.

Pier, Portland, Me.—According to Henry F. Merrill, chairman of the port directors of Maine, actual construction will soon be commenced on a large new pier for which the state has appropriated $1,500,000. The pier will be 1,000 feet long and 360 feet wide, with a depth of water alongside of 35 feet. It will be equipped with the most modern freight-handling machinery, and rates will be reasonable so as to attract business. It is expected that the pier will be completed in about a year.

To Change Vessel, Baltimore, Md.—Changes to be made in the steamer Hawkeye State will involve a general breakout of parts of the ship to make her accommodate different classes of passengers for which her trade on the Pacific makes a demand. There will be three bidders for the work, the Baltimore Dry Docks & Shipbuilding Company, Bethlehem Shipbuilding Corporation and the Newport News Shipbuilding Company. The work will probably require a month to complete. The vessel is now lying at Baltimore.

Steel Motorships Planned, New York—Preliminary plans for the construction of two 1,000 deadweight ton motorships are being prepared by Messrs. Seabury & de Zefra, Inc., 150 Nassau street, New York City, who have been commissioned by clients to provide for vessels up-to-date in every way. These ships will be of steel construction, operated by full Diesel engines, and all auxiliaries will be electrically operated. There will be accommodations for twenty-five first class passengers, and the ships will be equipped to attain a speed of 12 knots.

Repair Contracts Awarded.—The contract for repairing the steamer Persian of the Merchants & Miners' Transportation Company which was recently damaged by fire in Baltimore harbor was awarded to the Baltimore Dry Docks & Shipbuilding Company on a bid of $17,249 and 23 days to complete the work. Other bids for the job were as follows: Globe Shipbuilding & Dry Dock Company, $18,500 and 24 days; Newport News Shipbuilding Company, $22,580 and 18 days; Old Dominion Company of Norfolk, $51,506 and 90 days. Several other small repair contracts also awarded at Baltimore include the Shipping Board steamer Wahan, awarded to the Union Shipbuilding Company on its bid of $609; the steamer Westwood awarded to the Obrecht Company at $1,670; the Carenco to the Baltimore Dry Docks & Shipbuilding Company at $2,426, which was also awarded the Robin Adair, a Pacific Coast vessel.

Activities at San Pedro, Cal.—A contract for repairs to the steamer Edward Luckenbach, which recently went aground, has been awarded to the Los Angeles Shipbuilding & Dry Dock Company, the cost to total close to $60,000. The work will occupy three weeks' time, and will include bottom repairs, renewing one boiler head, four furnaces, and one main boiler, installing locomotive superheaters in three main boilers, installing an entire new gravity lubricating system for main turbine reduction gears, removing old and installing new reduction gears and pinions and making miscellaneous repairs to shaft pinions, etc. Other vessels to be repaired so far this month at this yard include the steam schooner Carlos, yacht Northtown, the destroyers 302 and 303, the steam schooner Stanwood; following which, it is understood, the steamers Cabrillo and Hermosa, two units of the Wrigley fleet in the Catalina Island service, and two additional destroyers will be docked for repairs.

SHIPS UNDER CONSTRUCTION IN VARIOUS YARDS FOR UNITED STATES NAVY

Vessels under construction for the United States Navy, their degree of completion and the probable dates of completion as reported April 30, 1921, are announced by the Bureau of Construction and Repair, Washington, D. C., as follows:

Type Number and Name	Contractor	Per Cent. of Completion May 1 Total
BATTLESHIPS (BB)		
44 *California*	Mare Island Navy Yard	96.5
45 *Colorado*	New York S. B. Corpn.	71.3
46 *Maryland*	Newport News S. B. & D. D. Co.	98.3
47 *Washington*	New York S. B. Corpn.	63.1
48 *West Virginia*	Newport News S. B. & D. D. Co.	52.1
49 *South Dakota*	New York Navy Yard	29.1
50 *Indiana*	New York Navy Yard	25.8
51 *Montana*	Mare Island Navy Yard	22.1
52 *North Carolina*	Norfolk Navy Yard	29.4
53 *Iowa*	Newport News S. B. & D. D. Co.	19.3
*54 *Massachusetts*	Beth. S. B. Corpn. (Fore River)	3.
BATTLE CRUISERS (CC)		
1 *Lexington*	Beth. S. B. Corpn. (Fore River)	16.6
2 *Constellation*	Newport News S. B. & D. D. Co.	9.3
3 *Saratoga*	New York S. B. Corpn.	20.4
4 *Ranger*	Newport News S. B. & D. D. Co.	1.6
5 *Constitution*	Philadelphia Navy Yard	6.
6 *United States*	Philadelphia Navy Yard	6.
SCOUT CRUISERS (LIGHT CRUISERS CL)		
4 *Omaha*	Todd D. D. & Const. Corpn.	91.4
5 *Milwaukee*	Todd D. D. & Const. Corpn.	88.3
6 *Cincinnati*	Todd D. D. & Const. Corpn.	80.6
7 *Raleigh*	Beth. S. B. Corpn. (Fore River)	53.8
8 *Detroit*	Beth. S. B. Corpn. (Fore River)	53.6
9 *Richmond*	Wm. Cramp & Sons Co.	64.
10 *Concord*	Wm. Cramp & Sons Co.	62.
11 *Trenton*	Wm. Cramp & Sons Co.	44.
12 *Marblehead*	Wm. Cramp & Sons Co.	42.
13 *Memphis*	Wm. Cramp & Sons Co.	35.
*Battleship No. 54—Keel laid 4-4-21.		
AUXILIARIES		
Fuel Ship No.1 8, *Pecos* (Oiler AO6)	Boston Navy Yard	82.5
Amm. Ship No. 2, *Nitro* (AE2)	Puget Sound Navy Yard	Comm.
Repair Ship No. 1, *Medusa* (AR1)	Puget Sound Navy Yard	60.6
Dest. Tender No. 3, *Dobbin* (AD3)	Philadelphia Navy Yard	57.3
Dest. Tender No. 4, *Whitney* (AD4)	Boston Navy Yard	21.
Sub. Tender No. 3, *Holland* (AS3)	Puget Sound Navy Yard	16.8
Aircraft Tender, *Wright* (AZ1)	Tietjen & Lang	70.
PATROL VESSELS		
Gunboat No. 22, *Tulsa* (PG22)	Charleston Navy Yard	64.6
Authorized but not under construction or contract. (1) Transport No. 2		
DESTROYERS		
135 *Tillman*	Charleston Navy Yard	Comm.
230 *Paul Jones*	Wm. Cramp & Sons Co.	Del.
250 *Lawrence*	New York S. B. Corpn.	Del.
327 *Preston*	Beth. S. B. Corpn. (San Fran.)	Del.
328 *Lamson*	Beth. S. B. Corpn. (San Fran.)	Del.
330 *Hull*	Beth. S. B. Corpn. (San Fran.)	Del.
331 *Mac Donough*	Beth. S. B. Corpn. (San Fran.)	Del.
332 *Farenholt*	Beth. S. B. Corpn. (San Fran.)	90.7
333 *Sumner*	Beth. S. B. Corpn. (San Fran.)	87.3
334 *Corry*	Beth. S. B. Corpn. (San Fran.)	81.
335 *Melvin*	Beth. S. B. Corpn. (San Fran.)	77.8
338 *Wasmuth*	Mare Island Navy Yard	97.5
339 *Trever*	Mart Island Navy Yard	94.6
340 *Perry*	Mare Island Navy Yard	59.5
341 *Decatur*	Mare Island Navy Yard	55.6
Destroyers authorized but not under construction or contract. (12) Nos. 348 to 359 inclusive.		
SUBMARINES		
115 *S-10*	Portsmouth, N. H., Navy Yard	90.6
116 *S-11*	Portsmouth, N. H., Navy Yard	86.2
117 *S-12*	Portsmouth, N. H., Navy Yard	76.2
118 *S-13*	Portsmouth, N. H., Navy Yard	72.3
123 *S-18*	Electric Boat Co. (Quincy)	97.
124 *S-19*	Electric Boat Co. (Quincy)	96.5
125 *S-20*	Electric Boat Co. (Quincy)	98.5
126 *S-21*	Electric Boat Co. (Quincy)	94.9
127 *S-22*	Electric Boat Co. (Quincy)	95.8
128 *S-23*	Electric Boat Co. (Quincy)	94.
129 *S-24*	Electric Boat Co. (Quincy)	93.
130 *S-25*	Electric Boat Co. (Quincy)	93.5
131 *S-26*	Electric Boat Co. (Quincy)	92.4
132 *S-27*	Electric Boat Co. (Quincy)	91.
133 *S-28*	Electric Boat Co. (Quincy)	91.6
134 *S-29*	Electric Boat Co. (Quincy)	90.5
136 *S-31*	Electric Boat Co. (Quincy)	97.5
137 *S-32*	Electric Boat Co. (Quincy)	94.4
138 *S-33*	Electric Boat Co. (Quincy)	99.2
139 *S-34*	Electric Boat Co. (Quincy)	94.5
140 *S-35*	Electric Boat Co. (Quincy)	89.6
141 *S-36*	Electric Boat Co. (Quincy)	86.
142 *S-37*	Electric Boat Co. (Quincy)	82.4
143 *S-38*	Electric Boat Co. (Quincy)	72.2
144 *S-39*	Electric Boat Co. (Quincy)	70.5
145 *S-40*	Electric Boat Co. (Quincy)	71.6
146 *S-41*	Electric Boat Co. (Quincy)	73.4
153 *S-42*	Electric Boat Co. (Quincy)	60.4
154 *S-43*	Electric Boat Co. (Quincy)	60.6
155 *S-44*	Electric Boat Co. (Quincy)	58.8
156 *S-45*	Electric Boat Co. (Quincy)	59.9
157 *S-46*	Electric Boat Co. (Quincy)	58.2
158 *S-47*	Electric Boat Co. (Quincy)	58.
159 *S-48*	Lake T. B. Co. (Bridgeport)	90.
160 *S-49*	Lake T. B. Co. (Bridgeport)	83.2
161 *S-50*	Lake T. B. Co. (Bridgeport)	73.5
162 *S-51*	Lake T. B. Co. (Bridgeport)	66.5
FLEET SUBMARINES		
60 *T-2* (SF 2)	Electric Boat Co. (Quincy)	98.7
163 *V-1* (SF 4)	Portsmouth, N. H., Navy Yard	
164 *V-2* (SF 5)	Portsmouth, N. H., Navy Yard	
165 *V-3* (SF 6)	Portsmouth, N. H., Navy Yard	

*Correction of error in report of April 10, 1921.

Note: Submarines authorized but not under construction or contract.
Fleet Submarines (6) Nos. 166 to 171.
Neff Submarine (1) No. 108.

SHIPYARDS AND DRYDOCKS

Marine Railway, Sydney, N. S.—The Sydney Foundry & Machine Works is reported to have started the construction of a new marine railway, which is expected to be completed and ready for the accommodation of ships during July.

Shipyard Addition, Petersburg, Fla.—The Marine Ways Machine Company, Seventh street, has plans under way for the construction of a one-story building, 50 by 150 feet, to cost $50,000, and into which new equipment will be installed, including grinders, pipe threader, lathe, etc.

Marine Railway, New London, Conn.—The Thames Tow Boat Company has commenced the construction of a third marine railway of 1,500 tons deadweight capacity, to be completed next October. The company has contracts for repair work on a number of United States submarines and Eagle boats.

To Establish Shipyard, North Vancouver, B. C.—The Queensboro Shipyards, New Westminster, B. C., are reported to be negotiating for the lease of two waterfront lots at North Vancouver, with the option of purchase, for the establishment of a shipbuilding yard there. Joseph Crane is manager.

Plant Addition, Philadelphia, Pa.—It is reported that the William Cramp & Sons Ship & Engine Building Company, Richmond and Norris streets, has acquired property at Fletcher and Richmond streets at a price of $105,000, to be used in connection with its plant. The land measures 124 by 375 feet.

To Enlarge Plant, Build Wharf, New Orleans, La.—The Jahncke Dry Dock & Ship Repair Company will spend about $2,000,000 for new equipment and extensions to its plant and will also build a new 600 foot steel wharf below their present yard, which will give them much needed additional steamer repair berths. The Dock Board of New Orleans recently granted the company the right to use the additional 600 feet on the riverfront.

PORT IMPROVEMENTS

Bulkheads, Eustis, Fla.—Bids are being readvertised for the construction of bulkheads. Pere Prioleau is city engineer.

Dock, Sarnia, Ont.—The Imperial Oil Company plans to build a dock on Confederation street to cost about $125,000 from private plans.

River Terminals, Memphis, Tenn.—City has voted bonds amounting to $500,000 for the extension of river terminals. W. B. Fowler is city engineer.

Wharf, Marion, Mass.—The town plans to build a concrete wharf on Sippican Harbor to cost about $25,000. The engineer has not as yet been selected.

Channel, Tampa, Fla.—The sum of $67,000 is available for the completion of a deep waterway channel between Tampa and Sarasota, Fla. Address the Mayor of Tampa.

Pier, Gulfport, Fla.—Bonds, amounting to $13,000, have been issued for public improvements, including pier construction, yacht basin, lighting system, etc. S. J. Webb is town clerk.

Concrete Dock, Dubuque, Ia.—Plans are being prepared by the United States Engineer's Office for a new steel and concrete wharf 300 feet long and estimated to cost about $100,000.

Docks, Miami, Fla.—Plans for trebling the capacity of the municipal docks and to erect an additional 1,000-foot pier, costing $400,000, are contemplated by the city. Address the city engineer.

Dredging, Clinton, Ia.—The Clinton Company is having plans prepared for dredging the Elk River 1½ miles, involving the expenditure of

about $25,000. B. Anderson, Western building, is engineer.

Wharf, St. Rose, La.—The Petroleum Import & Export Company, a subsidiary of the Carson Petroleum Company, has let a contract to N. G. Scott, Hennen building, New Orleans, for the construction of a 500 by 30-foot wharf.

Dredging, Gray's Harbor, Wash.—Actual dredging work has been started at Cow Point, the scene of the most extensive operations of the port development programme, and it is expected will take the greater part of the year.

Coal Terminal, Cordova, Ala.—Material for the coal terminal to be built at Cordova, the head of navigation on the Warrior River, has been contracted for and is being delivered. All necessary facilities of the most modern type will be installed.

Breakwater, Corpus Christi, Tex.—The citizens of Corpus Christi have voted in favor of an appropriation of $100,000 for the construction of a breakwater in connection with the establishment of a port at this point of the coast.

Wharf, Lahaina, Maui—Preparations are under way for the construction of a large wharf according to Honolulu reports. More than half of the concrete piling for the new landing has already been constructed, the date for the completion of the work being set for 1922.

Conveying Machinery, Jacksonville, Fla.—The City Dock Commission is planning for the installation of loading and conveying machinery on the municipal docks. This work, in connection with other improvements and extensions to the docks, will cost about $1,000,000. John S. Bond is chairman.

Bulkhead, Dredging, Newark, N. J.—The city let contract for dredging Newark Bay from Port Newark to Kill van Kull, and building a bulkhead around the waterfront property south of the channel at Port Newark, to the Atlantic, Gulf & Pacific Company, 15 Whitehall street, New York, on a bid of $739,082.

Wharves, Etc., Shiner, Tex.—It is reported that the Shiner Compress Company, of which V. J. Grunder is president, will soon erect wharves, 120 feet by 500 feet, and sheds of mill construction, to be built under their own supervision. Two tubular boilers, each 72 inches by 18 feet, will also be installed.

Terminals, Nashville, Tenn.—A. J. Dyer, chairman of the Board of Transportation, let a contract to Foster & Creighton to construct the concrete river and rail terminals, including a warehouse. The project involves the expenditure of $300,000. Freeland Roberts, Independent Life Building, is engineer.

Ship Terminal Bids, Edgewater, N. J.—According to latest reports the Luckenbach Steamship Company, 44 Whitehall street, New York, will soon call for bids for the erection of the first unit of its proposed new ship terminal at Bull's Ferry. Hoisting and conveying machinery and other freight handling equipment will be installed.

Ferry Terminal Power Plant, St. George, S. I.—The Department of Plant and Structures, Municipal Building, New York, has preliminary plans under way for the proposed municipal electric light and power plant at the ferry terminals, St. George, S. I., which is estimated to cost $1,258,000. Grover A. Whalen is commissioner.

Municipal Piers, Baltimore Md.—The Port Development Commission purchased a tract adjoining the city's McComas street development, the site having 429 feet of water frontage, 1,400 feet deep, and contemplates the construction of groups of municipal piers. H. G. Perring is chief engineer,, and Bancroft Hill, harbor engineer.

Wharf, New Orleans, La.—According to W. O. Hudson, president of the Board of Port Commissioners, plans for the construction by the board of a $400,000 wharf behind which a warehouse will be built by the Mississippi-Warrior Barge Line are now under way. The proposed wharf will be approximately 600 feet in length and 75 feet wide.

To Deepen Harbor, Nassau—The Bahamas Legislature has authorized the development of the harbor of Nassau, a project which was considered at various times during the past half century, at an estimated cost of $1,250,000, half of which will be raised by a loan. The harbor is to be deepened to 35 feet over the bar at the entrance, and channel will be made 300 feet wide and 35 feet to the inner harbor, where a basin 35 feet deep will be provided.

Ocean Terminal, Seattle, Wash.—According to an application made by the Oregon Washington Holding Corporation, which is an affiliated interest of the Oregon Washington Railway & Navigation Company, to the United States Engineers branch of the War Department, Seattle, Wash., it is probable that the Duwamish Waterway may soon have a new water terminal 1,000 feet long by 80 feet wide, with two warehouses 150 by 450 feet in connection. It is proposed to build an ocean terminal having a frontage of 1,000 feet on the waterway and permission is sought to dredge the channel to a depth of thirty feet at low tide.

Pier Equipment, Staten Island, N. Y.—Electric traveling cranes, hoisting, and conveying machinery will soon be installed on the new piers now being erected by the Department of Docks, New York, between Tompkinsville and Clifton, S. I., and involving the expenditure of about $20,000,000. The piers are expected to be available for use in the fall and several companies have already leased the piers, including the Oriental Navigation Company, 39 Broadway, pier 3; Pennsylvania Railroad Company, Penn. Station, Pier 5; American Dock Company, pier 6; Wessel, Duval & Company, 25 Broad street, New York, pier 8; Moore & McCormack, 5 Broadway, pier 9; Edward M. Raphel & Company, 17 Battery place, pier 10; International Mercantile Marine Company, 9 Broadway, New York, pier 11; Pan American Terminal & Dock Company, 233 Broadway, New York, piers 12 and 13; Nippon Yusen Kaisha, 120 Broadway, pier 17; and the Pouch Terminal, Inc., 17 State street, pier 18.

GOVERNMENT WORK

Air Compressor, Charleston, S. C.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., plans the installation of an air compressor.

Tower, Peking, China—Specification 4436, the Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to erect and paint one 300-foot steel tower.

Electric Light and Power System, Quantico, Va.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to install an electric light and power system.

Dredging, Mich.—The United States Engineer Office, War Department, Washington, D. C., has rejected bids for dredging Princess Point cutoff at Keweenaw Waterway Channel.

Electric Distributing System, Charleston, W. Va.—Specification 4418, the Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to install an electric distributing system.

Foundations for Machine Shop, Pearl Harbor, T. H.—Specification 4396, the Bureau of Yards & Docks, Navy Department, Washington, D. C., will receive bids until June 29 for constructing foundations for a machine shop.

River Improvement, Mich.—The Federal Government will spend $518,000 on improvements in the Detroit River during the coming year, according to an announcement credited to Major-General Beach, chief of the Government engineers.

Portable Water Supply, Lakehurst, N. J.—Specification 4424, the Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to install a portable water supply system.

Radio Station, Annapolis, Md.—Specification 4419, the Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to construct a high-power radio station and painting building.

Terminals.—The Government has leased a site from the city of St. Louis, Mo., upon which it will construct Federal docks, rail and river terminals, involving the expenditure of $250,000. Address Mr. Kiel, the mayor.

Dredging.—The United States Engineer Office, Room 710, Army Building, 39 Whitehall street, New York, will receive bids until 12 noon, June 23, 1921, for dredging and rock removal in the East River, New York. Further information may be obtained upon application.

Dredging Plant.—The United States Engineer Office, Jacksonville, Fla., will receive bids until June 10 to hire a dredging plant and crew for dredging and rock removal in the St. Johns River, Fla. Further information may be obtained on application.

Furnaces for Lighthouse Tender.—The Superintendent of Lighthouses, Boston, Mass., will receive bids until 2 P. M., June 6, 1921, for furnishing two furnaces for the tender Anemone. Further information may be obtained upon application.

Dump Scows, New York—The United States Engineer Office, Room 710, Army Building, 39 Whitehall street, New York, has let contract for furnishing and delivering three wooden hopper dump scows to the American Car & Foundry Company, 165 Broadway, at a cost of $194,862.

Dredging.—The United States Engineer Office, Jacksonville, Fla., will receive bids until June 10 for dredging and rock removal in the St. Johns River, Fla., to complete the work remaining in Arlington Cut from the unfinished contract. Further information may be obtained upon application.

Repair Steamer.—The Shipping Board has awarded to the Bethlehem Shipbuilding Company, Sparrows Point, Md., the contract to repair the steamer Conehatta on a bid of $2,530. The Baltimore Dry Docks & Shipbuilding Company bid $2,722, and the Globe Shipbuilding & Dry Dock Company $2,677.

Embankment, Dredging, Etc., Petersburg, Va.—The United States Engineer Office, Custom House, Norfolk, Va., will receive sealed bids until 12 o'clock noon, June 6, 1921, for constructing an embankment, earth fill, and dredging in the Appomattox River. Further information may be obtained on application.

Harbor Development.—Specification 4439, the Bureau of Yards and Docks, Navy Department, Washington, D. C., has let contract to the Great Lakes Dredging Company, 104 South Michigan avenue, Chicago, Ill., to construct a harbor at Great Lakes, Ill., at a price of $967,326. This work will occupy 500 days for completion.

Pier Contract Awarded, Charleston, S. C.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., let contract to the Raymond Concrete Pile Company, 140 Cedar street, New York, at a price of $191,600, to construct an extension to the concrete pier No. 314 at the Navy Yard. The pier will be extended from a length of 520 feet to 875 feet.

To Sell Lighter.—Sealed proposals will be received until 10 A. M., June 7, at the office of Lieut.-Colonel O. S. Eskridge, Infantry, Room 318, Pier 2, Hoboken, N. J., for the purchase of the steam lighter Amackassin. Each proposal submitted should be accompanied by a certified check of 10 percent of the amount of bid, checks to be made payable to the Finance Officer, Army Supply Base, Brooklyn, N. Y.

Twenty Ships to be Constructed—New ships to be built for the United States Navy include twelve destroyers, one transport, six fleet submarines and one Neff submarine, according to official figures given out by the Bureau of Construction and Repair, Washington, D. C. It is stated that these ships have been authorized but are not yet under construction or contract. The keel for battleship No. 54 was laid by the Bethlehem Shipbuilding Corporation on April 4, 1921, with probable date of delivery in 1923.

Light Vessels.—Sealed proposals will be received at the office of the Commissioner of Lighthouses, Washington, D. C., until 2 P. M., June 21, 1921, and at the office of the Superintendent

of Lighthouses, Custom House, San Francisco, Cal., until 11 A. M., June 21, 1921, for furnishing the materials and labor of all kinds except as stated in the specifications necessary for the construction, equipment, completion and delivery of three, four and five second-class, single-screw, steel, steam-propelled light vessel No. 106 and type, for use on the Atlantic coast to an authorized representative of the Bureau of Lighthouses at their place of construction.

Drill Boat, New York—Bids will be received until noon, June 30, by the United States Engineer Office, Room 710, Army Building, 39 Whitehall street, New York, for constructing and delivering drill boat E. R. No. 1, which is to be used in conjunction with improvements in the East River. This boat is to have a steel hull, 140 feet long by 50 feet beam, and it is believed that the cost will be in excess of $500,000. Machinery and equipment will include two watertube boilers, to be equipped with an oil-burning system and having a working pressure of 200 pounds of steam with 50 degrees of superheat, four cargo winches, two steam-driven three-wire direct-current generating sets, each capable of delivering 10 kilowatts at 110 and 220 volts from a steam pressure of 100 pounds. There will be ten rock drill engines, of which eight are to be installed.

NEW INCORPORATIONS

The Delta Navigation Company, Stockton, Cal., has been incorporated, with a capital of $200,000.

The Interways Line, Inc., Wilmington, Del., has been incorporated, with a capital of $1,000,000, to own and operate boats.

The U. S. S. Milwaukee Company, Wilmington, Del., has been incorporated with a capital of $500,000, for salvaging ships, etc.

The Seven Seas Steamship Company, Inc., Wilmington, Del., has been incorporated, with a capital of $90,000, to own and operate boats.

The Ethiopian Steamship Company, Norfolk, Va., has been incorporated, with a capital of $350,000, by C. P. Madison, president, and Frank Johnson, treasurer.

The Munalbro Steamship Corporation, Wilmington, Del., has been incorporated with a capital of $500,000 to own and operate boats, etc.

The Atlantic Coast Port Service Corporation, Wilmington, Del., has been incorporated, with a capital of $100,000; wharfage and berthing of ships, etc.

The Terminal Operating Corporation, 142 Pavonia avenue, Jersey City, N. J., has been incorporated, with a capital of $100,000, to carry on a transportation and lighterage business.

The Gulf Transportation Company, Ltd., Quebec, Can., has been incorporated, with an authorized capital of $50,000, to own and operate ships for transportation of freight and passengers and to act as common carrier.

The Houston Tampico Steamship Company, Houston, Tex., has been incorporated with a capital of $1,000,000, by Arthur W. Britton, 65 Cedar street, Samuel B. Howard and Austin H. Smith, all of New York City.

The Merchants & Manufacturers' Transit Corporation, Rochester, N. Y., has been incorporated, with a capital of $100,000, by H. Barnard, 36 Main street, West Rochester, for trade, commerce and navigation.

The Southern Disappearing Propeller Boat Corporation, Wilmington, Del., has been incorporated, with a capital of $150,000, to manufacture and sell boats having disappearing propeller devices.

The Adams Boat Line, Sarasota, Fla., has been incorporated with a capital of $50,000 to build, purchase, sell, own, equip, lease, charter, and operate vessels, etc. J. E. Battles is president, John Savarese, vice-president; H. S. Smith, secretary and G. B. Prime, treasurer.

The Atlantic, Gulf & Mediterranean Steamship Company, Ltd., Montreal, Can., has been incorporated, with a capital of $250,000, to own, operate steam and other ships, wharves, dry docks, railway and ship terminals, etc., and to carry on the business of common carriers of passengers and goods. J. E. Grivell, E. M. Jackson, B. M. Rogers, P. Schramm and H. G. McKeil, Montreal, are the incorporators.

FOREIGN ACTIVITIES

Reederei A.G. Phönix, Hamburg, has been formed by a number of Hamburg and Cologne firms to engage solely in sea shipping.

Drydock, Cadiz, Spain.—Messrs. Echevarrieta y Larrinaga of Bilbao, owners of the shipbuilding concern, Astilleros de Cadiz, contemplate the construction of a dry dock at this yard.

New Shipyard, Hamburg, Germany.—The firm of Paul Theodor Berendsohn has leased from the state of Hamburg a site on the R. Kohlbrand for sixty years, for the purpose of establishing a shipyard to be known as the Kohlbrand Werft.

New Shipyard at Ghent.—A new shipyard has been opened at Ghent. At present only slipways for ships from 300 to 400 tons are ready. The plans, however, include slips up to 15,000 tons, and work is being carried on energetically.

Start Work on Ferry Slip, Vancouver, B. C.—The Board of Harbor Commissioners, Vancouver, B. C., is reported to have started the construction of the proposed car ferry slip on the Vancouver North Shore. The estimated cost of the slip is about $60,000.

To Improve Port, Genoa, Italy.—The officials of the Commune of Genoa and the Independent Harbor Consortium are reported to have drawn up a plan for the constitution of an organization to improve the port, which will raise a loan of 150,000,000 lire for the purpose.

New Shipbuilding Yard, Blyth, Eng.—At a meeting of the Blyth Harbor Commission, proposals were submitted in connection with the development of a new shipbuilding yard in the upper harbor, and a provisional arrangement reached with regard to the dredging line.

Ship Contract, Hamburg, Germany.—The Hamburg-American Line is reported to have contracted with the Blohm & Voss yards for the construction of three passenger steamers of 22,000 tons each, and eight steamers of 6,000, the latter to be equipped with Diesel engines.

Launchings.—The Ardrossan Dry Dock & Shipbuilding Company, Ltd., launched on April 27, the S. S. Laatefos, built to the order of Otto and Thor Thoresen, Ltd., of Christiania. She is 255 feet in length and of 2,650 tons deadweight capacity, and will be fitted with triple expansion engines.

To Construct Diesel Engines, Greenock.—J. G. Kincaid & Company are about to undertake the construction of Diesel engines on the Burmeister & Wain system, and have secured a sub-license from Harland & Wolff, which firm holds the sole license for Great Britain and its colonies for the construction of this type of engine.

The Palmer Shipbuilding & Iron Company, Hebburn-on-Tyne has launched the oil tank steamer San Gaspar, which was built to the order of the Eagle Oil Transport Company of London. The vessel is 548 feet in length and of 18,000 tons deadweight, and was built on the Isherwood system of longitudinal framing.

Launching, West Hartlepool.—The steel screw steamer Saint Denis, built to the order of the Société Navale de l'Ouest, Paris, was launched on April 22 by Messrs. William Gray & Company, Ltd. The vessel is 321 feet 3 inches in length, with a breadth of 46 feet 6 inches. The vessel is equipped to burn either coal or oil fuel.

Tonnage Output on the Wear.—During the month of April only two vessels were launched on the River Wear. This makes the total output for the four months of the present year nine vessels, with a total tonnage of 38,782 gross, compared with 22 vessels, with a total tonnage of 102,251, during the corresponding period last year.

Largest Motor Ship.—The Ocean Steamship Company of Liverpool (Alfred Holt & Co.) are understood to have a motor ship on order which will be the largest afloat. Her deadweight capacity will be about 15,000 tons, and she will have twin-screws, driven by Burmeister & Wain Diesel engines with a combined indicated horsepower of 6,400.

Launching, Pallion, Sunderland.—The steamer George M. Embiricos, built to the order of S. G. Embiricos, Athens, London and Cardiff, was launched at the yard of Short Brothers, Ltd. The ship has a length of 458 feet, a beam of 56 feet and a moulded depth of 30 feet 9 inches. She is constructed to meet the highest class of Lloyd's rules.

Hopper Vessels Ordered, Chepstow, South Wales.—The Monmouth Shipbuilding Company, Ltd., has secured orders for three single-screw hopper vessels, each to carry 1,000 tons, to be fitted with triple-expansion engines and high-class accommodation for officers, engineers and crew. The company has had plans prepared for equipping their yards for all classes of ship construction and engineering.

The single screw steel cargo steamer Frogner, which was built to the order of Fearnley & Eger, has been launched by Sir W. G. Armstrong, Whitworth & Company, Ltd. The vessel is 406 feet in length, and of 9,000 tons capacity with a speed of 11¼ knots. She has been built under special survey to meet the requirements of Lloyd's 100 A1 class and to conform to the rules of the Norwegian Board of Trade.

To Enlarge Port, Stockholm, Sweden.—The plans for enlarging the free port are now completed. The work is to be completed by July 1, 1925, and will cost about 30,000,000 kr. The area of the free port will be about 65 acres and the depth of water 30 to 33 feet. Two large piers, 1,150 feet and 1,480 feet in length and 55 to 62 feet in width, are to be provided. Together with the work already in hand the total cost of the port equipment will be 70,000,000 kr.

New Harbor, North Slesvig, Germany.—It has been proposed to build a new harbor in North Slesvig, which is to be arranged at the innermost port of the Hejlsminde Bay, where natural conditions are very favorable. For protecting the harbor two piers will be constructed and within the thus protected port which will have a depth of eight meters, one quay about two hundred meters in length is to be constructed, so arranged as to be extended by another 600 meters or more. This project will cost about one million kroners.

Morocco (French Zone).—A report from H. M. Consul-General at Tangier states that a new section of quay at Kenitra, 224 metres long, with open storage ground at the rear, has been authorized for contract. Two cranes to carry three tons each have been installed and are ready for service. The completion of existing work at Safi continues, also the preliminary work on the construction of the port for small barques. The port for small barques at Mogador is nearly completed with the exception of the clearing of the sandbanks, etc., for which purpose a dredger has been put into operation.

Docks, London.—The extension of the Victoria and Royal Albert Docks system, which the Port of London Authority have had in hand for so many years, is now nearing completion and expected to be formally opened on July 8. The new dock will have about 10,000 lineal feet of quayage, and part of the scheme provides for a dry dock 750 feet long and 110 feet wide to accommodate ships drawing up to about 35 feet of water. The new dock will have a water area of about 64 acres and an average breadth of 650 feet. The wet dock will connect with the existing dock by a passage of 100 feet spanned by a swing bridge.

Pier and Wharf, Vera Cruz, Mex.—It is reported that an agreement has been reached between the Mexican Government and an engineer covering a concession for the construction of a steamship pier and wharf at Vera Cruz. The wharf will have a length of 400 meters and a width of 100 meters, and will be constructed of stone and reinforced concrete. Warehouses and shelters adequate to handle merchandise passing over this wharf will be built, and it is calculated that seven ships can be handled at the same time. It is expected that the first half of the wharf will be completed and put to commercial use in about two years.

BUSINESS NOTES

The New York office of the Diamond Power Specialty Company has moved from 126 Liberty street to 90 West street.

The Chicago branch of the Lunkenheimer Company, manufacturers of engineering specialties, has moved from 188 North Dearborn street to 568 West Washington Boulevard, Cincinnati, Ohio.

The Power Specialty Company, manufacturers of Foster superheaters, economizers and oil stills, has opened additional offices located at 512 Reliance building, Kansas City, Mo., and 627 Linz building, Dallas, Tex. The Kansas City office is in charge of William F. Meyer and the Dallas office in charge of M. W. Brown.

The United States Shipping Board, under the Division of Operations, has opened an office at St. Louis, in the Liberty Trust building, which is the first inland office the board has established. Mr. T. Park is in charge of the new office. The purposes of this office are to establish a personal contact with the shippers of the Central Region, with a view to furnishing information as to trade routes and facilities of the American merchant marine at all ports.

The Western Electric Company and its exporting subsidiary, the International Western Electric Company, announce important changes in their executive ranks. Frederick Hayes Wilkins, European general manager of the International Company, with headquarters in London, has been elected a vice-president of his company. Mr. Richard Gregory, comptroller of the Western Electric Company, has been made a member of its board of directors. Mr. S. Wallace Murkland, who has been assistant comptroller of the American Company since 1918, is now general contract sales manager.

The interests and all patents and patent rights of the Duntley Pneumatic Tool Company have been acquired by the H. L. King Company, engineers and tool makers of Chicago, and Mr. King, president of the H. L. King Company has organized the Duntley-King Pneumatic Tool Company, an entirely new organization for the production of pneumatic tools and accessories. The new company has an organization and shop facilities skilled in the production of precision machine work and is now in production with general offices and factory at 1143-45 Diversey Parkway, Chicago, Ill.

George Oldham & Son Company, Baltimore, Md., manufacturers of pneumatic tools and appliances, announce the appointment of the following agents, who will carry a complete line of Oldham pneumatic tools, including chipping hammers, foundry hammers, riveters, scalers, holders-on, etc., as well as a complete stock of repair parts for all types of tools, in order to render prompt service to all concerns in their respective territories: Andrew-Mays Company, 505 Ellicott Square, Buffalo, N. Y.; Zorn & Barker, 80 E. Jackson Boulevard, Chicago, Ill.; J. R. Petley Company, 218 East Water street, Milwaukee, Wis.; H. B. Wilson Company, 915 Olive street, St. Louis, Mo.; Charles C. McGill, 702 Marquette building, Detroit, Mich.; George C. McKay & Company, 1046 St. Clair avenue, Cleveland, Ohio; Penn Machinery & Equipment Company, 2138 Oliver building, Pittsburgh, Pa.

TRADE PUBLICATIONS

Reilly Evaporator.—The Reilly self-scaling submerged type evaporator is described in detail in a pamphlet sent out by the Griscom-Russell Company, New York.

Census Takers of Industry.—The uses of automatic counters applied to all manner of machines are fully described and illustrated in a recent pamphlet issued by the Root Company, Bristol, Conn.

Lunkenheimer Valves.—A highly developed composite of the original Lunkenheimer valve construction principles, known as the "Ferrenewo" valves, is described in a pamphlet issued by the Lunkenheimer Company, Cincinnati, Ohio. Specifications and details of the construction, as well as price lists of various type valves, are given.

Pipe Stills.—A discussion of the main differences between the conventional tank still and the pipe still for refinery work is given in Bulletin 202 issued by the Power Specialty Company, New York. The catalogue includes a brief reference to the many advantages obtained by superheating the steam used in refinery work, and also notes and data of interest to refiners and pipe line officials on the flow of fluids in pipes.

Diesel Oil Engines.—A general review of the developments of the Fulton Iron Works Company, St. Louis, Mo., in the construction of Diesel engines, as well as a complete description of the four-cycle, A-frame construction embodied in the engine, is given in a catalogue recently issued by this company. The Fulton Diesel engine is based on the patents and designs developed by Franco Tosi, of Legnano, Italy, one of Europe's foremost builders of Diesel engines.

Curtis Steam Turbines.—The steam turbines of the Curtis type from 100 kilowatt to 3,500 kilowatt capacity, used for driving 60-cycle generators at 3,600 revolutions per minute, are described in Bulletin No. 42201-B issued by the General Electric Company, Schenectady, N. Y. Typical installations which have given excellent performance, as well as a detailed description of the construction of these turbines, are given in the catalogue.

Alloy Steels.—The methods of producing alloy steels are discussed in a non-technical way by G. Van Dyck, manager of the special steel department of the Joseph T. Ryerson & Company, Chicago, Ill., in a booklet recently published by this company. In detail, shop equipment, furnaces, heat treating processes, case hardening and testing of the steel are taken up in such a way that the average shop superintendent may select and buy the proper steel for any special work which he might have to handle.

MARINE SOCIETIES

AMERICA

AMERICAN SOCIETY OF NAVAL ENGINEERS

Navy Department, Washington, D. C.

President—Capt. A. J. Hepburn, U. S. N.
Secretary-Treasurer—Commander J. S. Evans, U. S. N., Bureau of Engineering, Navy Department, Washington, D. C.
Annual meeting and election, first Tuesday in October, other meetings at call of the President.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS

29 West 39th Street, New York.

President—Rear Admiral W. L. Capps, C. C., U. S. N.
Secretary and Treasurer—Daniel H. Cox.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS

29 West 39th Street, New York City.

UNITED STATES NAVAL INSTITUTE

Naval Academy, Annapolis, Md.

President—Rear Admiral Bradley A. Fiske, U. S. N.
Secretary and Treasurer—Commander H. K. Hewitt, U. S. N.

NATIONAL ASSOCIATION OF MASTERS, MATES AND PILOTS

National President—John H. Pruett, 423 Forty-ninth St., Brooklyn, N. Y.
National Treasurer—A. B. Devlin, 187 Randolph Ave., Jersey City, N. J.
National Secretary—M. D. Tenniswood, 308 Vine St., Camden, N. J.

LIST OF OFFICERS, AMERICAN SOCIETY OF MARINE DRAFTSMEN

President—C. E. Deiser, 6124 Nassau Road, Philadelphia, Pa.
Vice-President—E. H. Monroe, 902 Virginia Ave., Washington, D. C.
Secretary—B. G. Barnes, 47 Saville Ave., Quincy, Mass.
Treasurer—J. B. Sadler, P. O. Box 987, Norfolk, Va.
Executive Committeemen—G. W. Nusbaum, Washington, D. C.; A. H. Haag, Baltimore, Md.; John Thomson, Bethlehem, Pa.

NATIONAL MARINE ENGINEERS' BENEFICIAL ASSOCIATION OFFICERS

National President—Wm. S. Brown, 356 Ellicott Square Bldg., Buffalo, N. Y.
National Secretary-Treasurer—Geo. A. Grubb, 356 Ellicott Square Bldg., Buffalo, N. Y.

ATLANTIC COAST SHIPBUILDERS' ASSOCIATION

1701 Walnut Street, Philadelphia, Pa.

Secretary—C. S. King.

AMERICAN STEAMSHIP OWNERS' ASSOCIATION

17 Battery Place, New York

Vice-President and General Manager—Winthrop L. Marvin.

AMERICAN STEAMSHIP OPERATORS' ASSOCIATION

17 Battery Place, New York

CANADA

GRAND COUNCIL, N. A. OF M. E. OF CANADA

Grand President—E. Read, Rooms 10-12, Jones Building, Vancouver, B. C.
Grand Vice-President—Jeffrey Roe, Levis, P. Q.
Grand Secretary-Treasurer—Neil J. Morrison, Box 886, St. John, N. B.
Grand Conductor—E. A. House, Box 333, Midland, Ont.
Grand Door Keeper—Lemuel Winchester, 306 Fitzroy Street, Charlottetown, P. E. I.

GREAT BRITAIN

INSTITUTION OF NAVAL ARCHITECTS

5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

39 Elmbank Crescent, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORPORATED

The Minories, Tower Hill, London.

ITALY

COLLEGIO DEGLI INGEGNERI NAVAL E MECCANICI IN ITALIA,

Via Carlo Alberto 18, Genova.

SMITHSONIAN LIBRARIES
3 9088 02026 0345